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Documenting Nesting and Breeding Ecology with Time Activity Budget of White-throated Kingfisher (*Halcyon smyrnensis*) in Swat, Pakistan

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AK, FB, ER, and SA conceived and designed the study and collect data. ER,FB, SA & RHK analyzed the data. ER, FB, SA, TK and NUK wrote the manuscript. RHK interpreted results and reviewed the draft.

Key words
White-throated kingfisher, Time-budget, *Halcyon smyrensis*, Breeding ecology

ABSTRACT

White-throated kingfisher *Halcyon smyrensis* is a common resident of wetlands in Asia including Pakistan. Breeding ecology and time budget activity was investigated in 16 active nests at 6 different sites during the current study. Nest construction was primarily initiated by the male while female joined later on. Mean size of circumference of the nest was 3.27 inch, mean length of tunnel 2.82 feet. Clutch size varied between 1 and 5 with an average of 3.25 per nest. Both parents incubated the eggs which hatched after a duration of 15-18 days. Hatching success was 94% while survival of fledglings was 90% in the study area. The most dominant activities performed by the white-throated kingfisher was flying (33.3%) and resting (33.3%) followed by hunting (25.1%) and preening (8.3%). Flying and hunting activities are mostly concentrated in the early morning and evening times which correspond to the energy needs of the species and the resting time peaked during mid-day, may be associated with temperature coping strategy. Difference observed in pre and post hatching activity patterns may be attributed to time needed for incubation and responsibility of providing food to the young ones. White-throated kingfisher makes need based time allocation for various activities to increase reproductive success. The current study documents important ecological and behavioral aspects of white-throated kingfisher. Nevertheless, it is limited to a single breeding season in a small area therefore making broader generalization may not be appropriate based on this study. However, this can be used to replicate the study for month or season wise data collection for better understanding behavioral ecology and time budget activity of the species.

INTRODUCTION

White-throated kingfisher or white-breasted kingfisher *Halcyon smyrensis* is a common species of a variety of habitats including plain countries with trees (Ali and Ripley, 1983), perches, agricultural areas, swamps, marshes, near ponds (Woodall and Kirwan, 2015) and lakes, in parklands and in mangrove swamps (Anderton and Rassmussen, 2005). The species is monogamous with bi-parental care, male starts digging the favorite site up to 50 cm to lay their eggs which are incubated by both the partners; after hatching chicks are fed and cared by both the parents (Ali and Ripley, 1983; Wells, 1999; Woodall and Kirwan, 2015).

White-throated kingfisher has wide distribution range and it extends from Turkey in the west to the Philippines in the east spreading across Afghanistan, Bangladesh, China, India, Iran, Pakistan and parts of Southeast Asia (Fry *et al*., 1992; del Hoyo *et al*., 2001; Anderton and Rassmussen, 2005). It is resident throughout much of the Indian subcontinent (Grimmett *et al*., 1998). Though, being prone to certain pressures like habitat degradation, loss of prey as A result of agricultural pesticides, it has stable population and classified as Least Concern by International Union for the Conservation of Nature (IUCN) in its worldwide assessment (BirdLife International, 2017).

White-throated has distinct thick and reddish-orange bill, with prominent red legs, dark brown head and shoulders. The upper parts of the wings and tail are

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turquoise blue while a vivid white patch can be found on the throat and breast (Anderton and Rassmussen, 2005).

The white-throated kingfisher is carnivorous (so called sit and wait predator) (Ali and Ripley, 1983) and eats many of the insects and other organisms (Asokan *et al*., 2009) for example, crustaceans (Roza, 1995), earthworms (Yahya and Yasmin, 1991), rodents, fish and frogs (Roberts and Priddy, 1965; Naher and Noor, 2014).

The white-throated kingfisher plays a vital role in check and balance of the various populations because they feed on a wide variety of creatures. The white-throated kingfisher is also involved in parasitism by protists of the genus plasmodium species *Haemoproteus halcyonis* (blood parasite of the other halcyon species) uses the white-breasted kingfisher as a host (Ali and Ripley, 1983). As a pest control agent white-breasted kingfisher is thought agriculturally beneficial bird (Asokan *et al*., 2009).

Time budgeting is an important quantitative parameter used in developing ethological profiles and describing activity pattern of animals (Ramachandran, 1998). Many behavioral traits can be deduced from the study of time budgeting of animals. The proportion of time allocated for different activities varies from species to species and seasonally and depending various factors (Asokan and Ali, 2010). Better understanding of behavioral ecology can help in protection and conservation of animals. Despite being wide spread in Pakistan, there is a lack of published data on the ecology and behaviour of the species. Some studies have been conducted in the neighboring countries where it occurs including India and Bangladesh (Palkar *et al*., 2008; Ali *et al*., 2010). The current study was thus designed to investigate the breeding and nesting ecology of white-breasted Kingfisher in a suburb region of Swat, Pakistan.

MATERIALS AND METHODS

Study area

The study was conducted in Kokarai valley of District Swat, Khyber Pakhtunkhwa (Fig. 1). Kokarai Valley located at 34° 44'.645" North, and 72° 27'.628" East, 1085m a.s.l on the north-western side of District Swat at Hindu Raj series of Hindu Kush Mountains range (Asim *et al*., 2016), encompassing an area of about 28 km^2. The maximum temperature recorded during summer (June-August) ranges from 38 to 43 °C, while in winter the minimum average temperature drops from 15 to 18 °C during the months of December to February. Frequent rainfall is experienced in month of March with 238 mm and the maximum relative humidity can be detected in the month of February with 80% (Yousfzai *et al*., 2010).

The natural vegetation of Kokari Valley can be classified as; subtropical pine forest at lower elevations and temperate forests at higher elevations (Beg, 1975). Dominant plant species of the study area includes *Pinus roxburghii, Dodonaea viscosa, Robinia pseudoacacia, Melia azedarach, Ailanthus altissima, Ficus carica, Eucalyptus* spp., *Populus* spp. etc. The common mammalian species found in the area are represented by golden jackal (*Canis aureus*), red fox (*Vulpes vulpes*), cape hare (*Lepus capensis*), and Indian crested porcupine (*Hystrix indica*), while species of conservation importance found in the surrounding area are common leopard (*Panthera pardus*) and leopard cat (*Prionailurus bengalensis*). Birds of conservation importance are represented by chukor patridge (*Alectoris chukar*), grey francolin (*Francolinus pondicerianus*), black francolin (*Francolinus francolinus*) etc.

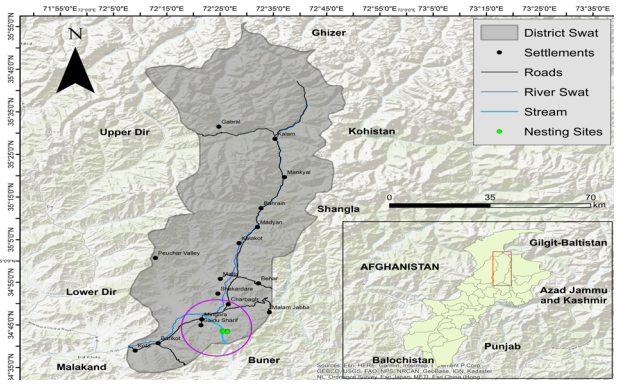

Fig. 1. Study area map and locations of nesting sites of white-throated kingfisher in the study area.

Survey method

The present study was conducted in May-June, 2016 in Kokarai valley. A total of 16 breeding pairs of white-throated kingfisher were monitored in this study to gain information on the breeding ecology of the white-throated kingfisher. A binocular (Nikon Aculon 10X50) was used to observe the white-throated kingfisher while camera (Panasonic GH4) inside camouflaged tent was used to document its various aspects of behavior as pictorial proof. Similarly, camera (GoPro) was fixed inside the empty nest before the egg laying season to record the feeding behavior of chicks. A measuring tape (Naher and Sarker, 2016) was used to measure the diameter of the tunnel opening, length of the tunnel, height of the tunnel from ground and distance of tunnel from the tree used by the kingfisher as perching site. The clutch size in each tunnel was counted and the behaviors of the breeding pairs was recorded.

Each day was divided into four time blocks: Early morning (06:00-09:00), late morning (09:00-12:00), midday or afternoon (12:00-15:00) and late evening

(15:00-18:00). Behavioural data were collected using the focal animal sampling technique of Altmann (1974). The pattern of observation in each time block was in each one hour, there were three 15-min continuous monitoring periods followed by a 5-min break. During each 15-min period, only one bird was monitored. Behaviors were categorized into four categories:

Hunting (Feeding): Capturing the prey and maneuvering them into the mouth prior to swallowing.

Flying: Bird in flight, very often in pursuit of prey.

Preening: Included of all forms of comfort movements including feather shaking, wing flapping, bill cleaning, bill scratching, body-shaking and tail- shaking.

Resting: Perched birds that were sleeping or dozing, with the head retracted and eyes closed.

We used One-way Analysis of Variance (ANOVA) to compare each activity among time blocks. Data was analyzed in Microsoft Excel 2013 and MINITAB package (Minitab Inc. 2007). Significance level was set at $P>0.05$. Map of the study area was projected in ArcGIS 10.3.

RESULTS AND DISCUSSION

Characteristics of constructed nest

White throated kingfisher (*Halcyon smyrnensis*) breeds from May to June in the study area although in other areas courtship starts early in March (Palkar *et al*., 2008). A total 16 active nests of white-throated kingfisher were observed at 6 different sites along the bank of Kokarai stream. The minimum circumference of tunnel opening was 2.27 inch, while the maximum opening was 3.9 inch (mean=3.27 inch). Minimum length of the tunnel recorded was 2.3 feet while maximum length of the tunnel was 3.2 feet (mean=2.82) (Table I). Nest tunnel was constructed with an average distance of 20 feet (10-25 feet) from perching site. The minimum distance of constructed tunnel from ground was 5.8 feet and maximum height was 20.5 feet (mean=7.53 feet) (Table I). *Ailanthus altissima* and *Melia azedarach* were the two tree species used by the white-throated kingfisher as perching site. Soil in the river bank was suitable for construction of nest due to two reasons; the soil consists of sandy loam which is easier to excavate and the nearby water provides food source and perching sites. Average length of the nest tunnel varied but remained less than one meter (Table I) as compared to other studies (0.61m) such as reported by Palkar *et al*. (2008). Similar was the case with other features such as tunnel circumference. We are confident that the measurements presented in this study are more realistic given the reliability of methodology used in other studies.

Clutch size and incubation period

A total of 52 eggs were counted at 16 different nesting sites. The minimum clutch size observed was one egg, while the maximum clutch size was 5 eggs in a single nest. The average number of eggs per nest was 3.25 eggs (Table I). The observed eggs of white-throated kingfisher were oval shaped and white colored, similar observations were also made by Ali and Ripley (1983) and Palker *et al*. (2008). However, we also found dark black pigmentation on its surface (Fig. 2). The incubation period ranged from 15-18 days, which slightly varies from study of Ali *et al*. (2010) as their findings were 14-17 days. After hatching, the chicks remain dependent on their parents in the nest for provision of food and care up to a period of 19-23 days. Interval between laying the first egg and subsequent laying was irregular ranging from over one night to two nights. The study also found variations between incubation, hatching and fledging periods recorded in this study and other studies dealing with common kingfisher (Palkar *et al*., 2008; Ali *et al*., 2010), and this is most probably due to the difference in climatic and environmental conditions. Exploring and understanding the causes of such variations warrants further studies. Minimum and maximum clutch size recorded in this study is also lower than that recorded by Palkar *et al*. (2008), but were in conformity with results of Ali *et al*. (2010). The clutch size may be influenced by a number of factors including age of the birds, food availability and breeding season (Borah, 2011; Naher and Sarker, 2016).

Fig. 2. Nesting tunnel, clutch size, chicks in the tunnel and hunting activities of the white-throated kingfisher.

Breeding success

Of the total 52 eggs recorded at 16 different nesting sites, 49 hatched (94%) and 44 fledged (90%). Only two eggs were found infertile while one egg was abandoned at two different nesting sites and 49 eggs were successfully hatched. Of the 49 hatched, the mortality of five individuals occurred in early-stage for unknown reasons. Hatching rate was 94% while survival rate was nearly 90% in the current study.

Table I. Physical characteristics of constructed tunnel by white-throated kingfisher for breeding activity.

Sr. No	Clutch size	Circumference of tunnel opening (Inches)	Length of tunnel (Feet)	Distance of perch (Feet)	Height of nest from ground (Feet)
1	3	3.3	2.3	20	6.5
2	5	3.5	2.7	17	6.2
3	2	3	3	13	5.8
4	1	3.8	3.1	10	6.1
5	3	2.7	2.8	20	6
6	2	2.9	2.8	19	6.2
7	5	3.1	2.3	25	20.5
8	5	3.7	2.5	23	11.4
9	3	2.9	2.6	19	6.8
10	2	3.4	2.8	21	6.9
11	3	3.3	3	23	6.4
12	3	3.9	3.2	22	6.6
13	5	3.2	2.9	24	6.6
14	4	3.1	3	25	6.2
15	3	3.1	2.8 f	24	6.1
16	3	3.5	2.8	16	6.1 ft
Mean	3.25	3.27	2.82 ft	20.06 ft	7.53 ft

Activity recorded

The activity of white-throated kingfisher was monitored for 12 h daily during the two-month study period. Four different types of activities were observed; hunting, flying, preening and resting. The most dominant activity performed by the white-throated kingfisher was flying (33.3%) (df=3.21; F=5.85; p=0.002) and resting (33.3%) (df=3.84; F=4.26; P=0.017) followed by hunting (25.1%) and preening (8.3%). A high percentage of hunting and flying activities were performed early in the morning (df=2.32; F=1.86; p=0.017) while resting and preening activities were mostly performed at noon (Table II). The white-throated kingfisher spent most of their daytime in search of prey. scanning is the widespread behavior in predatory birds (Ettinger and King, 1980; Mahabal, 1991, Sivakumaran and Thiyagesan, 2003).

Difference was found in pre-hatching and post-hatching activity patterns (df=2.38; F=4.67; P=0.001) of white-throated kingfisher in the study area. An increasing trend in the duration and frequency of post hatching activities was found as compared to the pre-hatching activities pattern (Fig. 3). This is due to the fact that during pre-hatching the birds spend most of the time incubating eggs and feeding themselves while additional responsibility to feed the young ones needs more time allocation to hunting and preying during the post-hatching period. Almost equal time was allocated for flying and resting which varied considerably between different times of the day. Early morning and evening times were allocated to fulfill energy requirements while mid-day; when temperature is comparatively high, the species spent in rest and doing body maintenance. Resting time was considerably high as compared to 4% reported by Ali *et al.* (2010). Most of the diurnal time allocated to scanning for prey and hunting was in line with other studies reporting time budget activity of the species (Ali *et al.*, 2010; Asokan and Ali, 2010). The current study focused a single breeding season without incorporating seasonal and yearly variations which may not permit for broad generalization.

Table II. Different types of activities performed by white-throated kingfisher during the study period.

Activity type	Activity %	6:00-9:00 %	9:00-12:00 %	12:00-15:00 %	15:00-18:00 %
Hunting	25.1	55%	10%	2%	33%
Flying	33.3	35	27	10	28
Preening	8.3	10	25%	40	25
Resting	33.3	8	38%	42	12

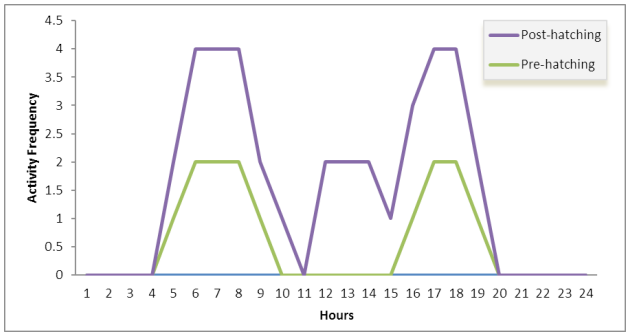

Fig. 3. Pre and Post-hatching Activities Pattern of White-throated Kingfisher during the breeding period in the study area.

Feeding and fledging

The newly hatched chicks were featherless, immotile and pinkish during the study period as illustrated in (Fig. 2). The activity pattern increased and both parents were involved in searching and picking of food for new fledglings. The young ones were mostly fed by the small sized fish and frogs captured by the white-throated kingfisher from a nearby stream while occasional diet included small sized geckos, lizards and many unknown

invertebrate species. The chicks started to assemble at opening of nest after seven days in order to receive food and communicate in low chuckle with their parents. The movements increased with the development of feathers on their body and became noisy and competitive in receiving meal from parents in the second week. The time budget activity enhanced in the start of third week (df=5.12; F= 9.76; p= 0.04) and started spending more time at the entrance of nest actively communicating with their parents. The fledging duration was 19-23 days, by the end of third week, at early in all the nests under observation.

CONCLUSION

Breeding ecology and time budget activity of common kingfisher was observed at six different locations in the study area. Average clutch size was 3.25, hatching success 94% and fledgling survival rate 90%. A considerable difference in time allocated to various activities before and after hatching was observed which reflects need based time allocation by the species. Some aspects of breeding ecology and time budget activity differ from other studies conducted in the neighboring countries. The current study records important behavioral and ecological aspects of the species, yet, limited to a single breeding season hence need replication encompassing multi-seasonal studies. Data collected on monthly, seasonal basis can be useful for understanding and developing a complete picture of the time budget activity pattern.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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