Breeding biology of Indian whiskered tern *Chlidonias hybrida indica* (Stephens) at lake Wular Kashmir

Mustahson Farooq Fazili

Wildlife Research Division Postgraduate Department of Zoology, University of Kashmir-190006
drfaziliwl@yahoo.com

Abstract: Some parameters of breeding biology of Indian whiskered tern were studied for three successive years (2011-2013) in the lake Wular (34º15′ to 34º25′ N, 74º32′ to 74º42′ E), Kashmir, India. Terns arrived in the lake in April. Breeding occurred from May to August and was initiated by pair formation.The whiskered terns were strictly monogamous. The nesting sites were generally chosen near reed beds with dense floating vegetation. *Trapa and Nymphoid* mats were mostly preferred .The water depth near nest site varied from1-2.5 meters. They were colonial and number of nests in a colony varied fom 15-179. Both the sexes built the nest in an average period of 5.25±0.8 days. Nests were substantial platforms with a mean diameter of 13.5 ± 0.9cm and average depth of 2.65± 0.2cm. Average clutch size showed both inter and intra annual variation with an overall mean of 3.16± 0.59. The freshly laid eggs weighed on an average17.212 ± 1.069g and their average length, breadth volume and shape index were 36.9 ± 0.50mm, 27.4 ± 0.20mm, 14.34 ± 1.80cm^3 and 74.23 ±0.475 respectively. The eggs showed on an average a gradual weight loss of 16.6% during incubation..In 65% of the clutches eggs were laid daily and peak laying was between June, 21 to July, 10. Incubation was performed by both the sexes during a mean period of 21.8±0.88days.Overall egg survival during incubation was0.34. Hatching was asynchronous and hatching period varied from 1-2 days.Over all hatching success calculated by traditional method was 28.82%.Humans predated 68% of the eggs incomparison to2.31%by natural predators. Nestling survival during nestling period was 0.25 and nesting success calculated from exposure was 0.26.
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1.Introduction

It is a well accepted fact that birds must breed successfully in order to invade and colonize a new habitat. The breeding process is the outcome of a myriad of complex activities that are brought about as a consequence of discrete morphological, anatomical and physiological changes under the influence of favourable environmental conditions. The process of breeding is thus an excellent expression of co-relations of various activities and adaptations evolved as a result of natural selection with the environmental and environment dependant conditions. As a result of physiological and anatomical changes a unique response is developed, in the form of activities that lead to the production of future generation in the presence of such environmental condition that are better suited for the purpose. The main environmental and environment dependant conditions include day length, suitable temperature, humidity and water level, availability of convenient nesting places and adequate food supply for raising of nestlings (Fazili,2002). Whiskered tern is found in colonies in the marshes , wetlands ans lakes of the valley which arrive from plains of India during summer.Their distribution is scattered, numbers fluctuate and they are threatened in many regions(Fatiha *et al* 2002).They inhabit central and southern Euerope,Africa and Southern Asia to Australia.There are a number of races of which two nest in Indian limits(Bates and Lowther,!952).During winter they migrate farther in to India, Shri Lanka and Burma. Being bird of least concern as per IUCN(Bird International, 2012), its breeding biology has occasionally been studied and there are only a few brief breeding reports.It was with this aim that a three year study (2011-2013) on the breeding biology of this bird was under taken at lake Wular Kashmir, India to have a detailed report regarding its differnt reproductive parametrs.

2. Material and Methods

2.1 Study area

The study was conducted from 2011 to 2013 at Wular Lake (34º15′ to 34º25′ N, 74º32′ to 74º42′ E), a Ramsar site in the Baramulla and Bandipore districts of Jammu & Kashmir, India. The lake has a maximum depth of 4.9 m with an area of 111.71Sq. Km (Latief 2012) that remains covered with dense growth of free floating and emergent vegetation during the major part of the year. The major species are *Trapa bicipinosa, Nymphoides peltatum, Nelambo nucifera, Ceratophyllum demersum, Hydrella verticellata, Potamogeton indicus, P. lucense, Butomus umbellatus, Carex sps., Phragmitis communis, P. elephantoides, Typha angustata, Myreophyllum*

verticellatum, Sparganum ramosum, Lemna sp. And Saccharum spontaneum. The dense floating vegetation and reed beds are partitioned by a series of boat channels varying in width between 1 – 6 meters. There is a protective bank mostly on the southern and eastern sides of the lake. Inside the bank and at some places outside the bank there are dense willow plantations of both tall and bushy *Salix* tree species that provide best roosting and breeding grounds to a wide variety of resident and non-resident birds. In addition, outside the bank on southern side of the lake there are two large marshy areas attached to the lake locally known as Rakhi Saderkote and Rakhi Muqdemyoor. These rakhs (morases) have dense growth of reeds and emergent and free floating vegetation of *Phragmitis communis, P. elephantoides, Typha angustata, Saccharum spontaneum, Sparganum ramosum, Eleocharis palustris, Carex species and Butomus umbellatus.*They also harbour a wide variety of aquatic bird species. The river Jehlum flows into the Wular lake on its south-east near the middle and leaves at its south-western corner near Sopore. (Fig.1). Besides Jehlum, the streams especially Erin, Mudhumati, Arrah and Ningal also feed the lake.

2.2 Methods

For the purpose of present investigation the lake was divided into ten sites (A-I) mainly on the basis of different vegetation, bird habitat preferences and other characteristics (Figure 1). Observations on Nesting ecology were carried out at five sites (Figure 1, A to E), because these areas had dense growth of both free floating and emergent vegetation and less human interference.

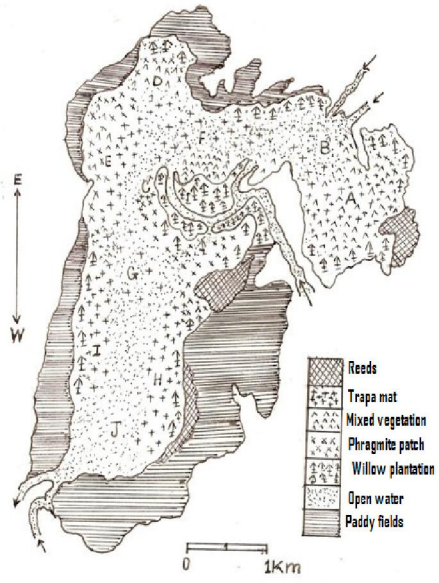

Figure 1. Map of Wular lake showing study sites

The entire floating vegetation areas in these sites were searched for nests during three consecutive breeding seasons from 2011-2013.Nesting site was defined as an area where mating, nest building, adult incubating and brooding occurred. The nests were generally located in the study sites by wading through shallow regions and by moving in a boat through the channels. Most searching was done close to boat channels. Any residing place of a bird with one or more eggs was classified as a nest. The nest sites were marked by slender willow stakes, flagged with small strips of white cloth at about a distance of 5 meters from the nest in a particular direction and plastic numbers were tied to the nest material. When a nest was spotted the following parameters were recorded (i) location (ii) nesting material (iii) plant species in the immediate vicinity of the nest and (iv) water depth at the nesting site. In addition, at each nest the type of vegetation cover and its condition, shape, size and the position of the nest and concealing arrangements if any were recorded. During laying each nest was visited daily and the newly laid eggs were weighed to an accuracy of 0.1 gm using 50gm balance. To determine egg laying and hatching intervals, the eggs were marked with water proof ink and placed properly in the nest without disturbing the arrangement of other eggs in the nest. Morphometric measurements of eggs were taken to 0.1 mm using Vernier Callipers. The length and width were measured at highest points of the egg, obtained by sliding the Calipers gently on the egg. The Volume was calculated by using the formula $V\ (cc) = K \times L \times B^2$ (Hoyt 1979), where L is the length, B is breadth and K is constant the value of which is equal to 0.51.Shape index (SI) of eggs was calculated as SI = W/L x 100 (Coulson 1963), where W = egg width in cm and L = egg length in cm. After laying eggs were weighed on alternate days till hatching. A few nests were found late where incubation of the eggs had already started. Their incubation period was estimated by egg immersion technique in which the eggs were immersed briefly in water along side of nest and judging the extent to which they sank or floated. This was compared with our previously determined scale in which sink/float characteristics of eggs of known age were assessed (Table 1*)*. Incubation period was measured from the day of egg laying till the emergence of chick from the shell. Efforts were made to determine causes of losses. Hatching was defined as the time at which first cracks appeared till complete emergence. The calculations for the hatching success were done in accordance with Mayfield (1961,1975).A movable hide was used to observe the birds as they nest in open vegetation. The hides were raised to record the behaviour of breeding pairs. Also 20×50X binoculars were used in the field for this purpose.

3.Results

3.1 Spring arrival and Pair formation

Indian whiskered tern, a regular summer migrant first arrived the lake in 2011 and 2012 on April, 15 and Apri1, 13 respectively. But during 2013 breeding season, they delayed their arrival till 27th April, when first group of 15 terns was sighted landing at the lake. The conducive environmental conditions and favourable temperatures augmented their arrival and by May, 10 regular visual census revealed their number as 516 in 2011, 613 in 2012 and 417 in 2013 (Figure 2). After their arrival, they moved in flocks ranging from 5 to 33, enjoyed feeding and flying over reeds and open waters, less often rested on willow stakes and allied things during day.Their arrival was marked not only by visual sightings but more often sensed by hearing their loud and sharp ' kreu-kreu krech' calls.

Indian whiskered terns were strictly monogamous.As the environmental conditions became conducive, the terns developed their peculiar breeding colour and plumage: their beaks and legs turned red and body plumes more and more dark grey. They congregated in flocks and roosted together on a particular patch of floating vegetation and initiated pair formation displays which included chasing of females, fighting with the rival males, performing strutting displays and fish offering ceremonies. The most remarkable displays were fish offering and strutting displays. During fish offering display, the males generally flew above the females with a fry or a small fish in their beaks to advertise their unpaired status. The females that were in search of their desired mates either responded by following or flying towards the males who offered the fish. During strutting display male generally moved in front of the female with a different gate, during which head was raised and chest exposed to express body strength to impres the female.The females generally assessed the strength of a male by the size and amount of the fish they were fed and selected only that male who had best tendency to feed them.

3.2 Nest characteristics

The nesting sites were chosen near reed beds with dense floating vegetation in the viscinity or in areas with dense floating vegetation and occasional reeds or other aquatic plants that reached the surface and provided anchorage to the floating nests.The sites chosen were generally in far away places with less human interference and mild impact of predators and a few in almost concealed areas,with reeds all round and the water depth between 1 to 2 metres.The early arrivals preferred shallow peripheral regions of the lake with average water depth 1.5m and late nesting pairs preferred central regions of the lake with an average depth of 2 meters. The concealment in central area of the lake was very poor but nests had enough support not to be shattered by fluctuations in the water column.The nesting sites were characterised by high growth of *Sparganum ramosum, Typha angustata, Phragmites communis* and *Saccharum spontaneum which* provided concealment and the *Nymphoides peltatum, Potomogeton lucense,, P. amphobium* and *Trapa natans* which formed floating vegetation that provided the base for the nests.

The terns were colonial and a total of 11 colonies were established: 3 in 2011, 6 in 2012 and 2 in 2013. The colonies were far apart from each other and the distance varied from a minimum of 11o meters to a maximum 875meters.The colony comprised of a minimum of 15nests to a maximum of 179 nests. A total of 869 nests were recorded in 11 colonies, 322 during 2011, 473 in 2012 and 74 nests in 2013 (Table 1). Nest building activities were initiated only when the water surface was densely covered with floating vegetation. Both sexes built the nest. Generally males collected nesting material and females did most of the building and architectural work.The nests were simple platforms formed of stems of variable lengths, placed hardly an inch or so above the water surface The nesting material required for nest building was either collected from nearby area or far away from the nest site. The intensity of the nest building was high during morning hours and around noon it was very slow or almost ceased and resumed in the evening but with less intensity. The time taken to complete the nest varied from 3-7 (average5.25±0.8) days before laying.

The nests were simple floating platform with raised centres of dead reeds. The central raised part varied in diameter from 10 to 15 cm(Mean13.5± 0.9cm) with a shallow depression of 2.5 to 2.9 cm(average2.65± 0.2cm).The nesting material mostly comprised of stems of *Phragmites communis, P. elephantoides, Typha angustata, Sparganium ramosum, Nymphoides spp., Oryza sativa, Saccharum spontancum and, Potomogeton spp.*

Table 1: Distribution of colonies & nests of Indian whiskered tern in the study area.

Year	**2011**		**2012**		**2013**		**Total**
Site	No. of Colonies	No. of nests	No. of Colonies	No. of nests	No. of Colonies	No. of nests	
A	2	143	1	35	-	-	178
B	-	-	1	15	-	-	15
C	1	179	1	133	-	-	312
D	-	-	1	81	1	46	127
E	-	-	2	209	1	28	237
Total Colonies/Nests	**3**	**322**	**6**	**473**	**2**	**74**	**11/869**

3.3 Clutch and egg biometry

The clutch size varied greatly from 1 to 5, with a mean of 3.16 (Table 2). Average clutch size did not remain the same but showed both inter and intra annual variation with a range of 3.02 to 3.27 and 2.98-3.43 respectively (Tables 2&3). In the early arrivals and those that completed their-nests earlier, the egg laying was initiated in May. However, during 2013 laying was initiated in first week of June(Table 5). In majority of the colonies laying was completed in a mean duration of 19.7 days(range12-25days).Laying actually depended on the size of the colony i.e. number of breeding pairs/nests it contained. The larger the colony more time duration required to finish laying. In some cases few pairs were still laying when others had hatched their nestlings. Though laying was initiated in May but majority of eggs 46.61% and 41.27% were laid in June and July respectively.

Table 2. Eggs per clutch/ number of clutches in Indian whiskered tern.

Year	Clutch Size					Average clutch±SD	Total
	1	2	3	4	5		
2011	6	15	200	88	13	3.27± 0.69	322
2012	4	14	389	58	8	3.10± 0.50	473
2013	5	1	56	11	1	3.02± 0.70	74
Total	15	30	645	157	22	3.16±0.59	869

In 2013, only 224eggs were laid in 74 nests and in 2011 and 2012, 1053 and1471 eggs were laid in 322 and 473 nests respectively. The maximum number of the eggs were laid between June, 21 to July, 10 during three years of study (Fig.2). 85% of the eggs were laid in the morning between 7.00hrs to l0.00hrs. In 65% of clutches, eggs were laid daily and in 35% of clutches, eggs were laid on alternate days. Perhaps young and inexperienced females laid on alternate days while as adult ones laid daily.

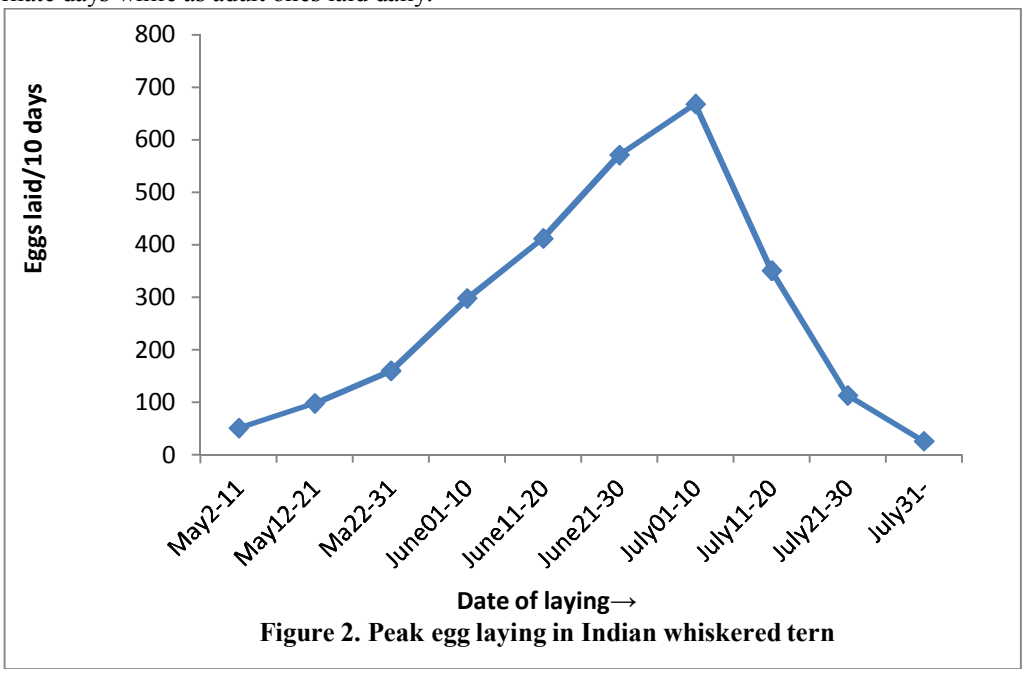

Figure 2. Peak egg laying in Indian whiskered tern

The eggs were of variable colour with quite varied markings mostly confined to broader end. They were generally glossless with a shade of light sea green when fresh but their colour changed to yellowish brown when incubation proceeded- Some eggs were pale grey.The markings were deep chocolate or purplish brown speckles.The eggs were simple with a small end that is some times pointed.The weight of freshly laid eggs varied from a minimum of 15.450 g to a maximum of 18.900g with an average weight of 17.212 ± 1.069g.

Table 3. Completion of clutch in Indian whiskered tern

No. Of Clutches	1	2	3	4	5	Total	**Clutch size ± SD**
No. of nests	15	30	645	157	22	869	3.16± 0.59
May,2 to May,21	--	--	32	16	3	51	3.43±o.5
May,22 to June,10	1	1	73	37	5	117	3.37±0.7
June, 11 to June, 30	1	5	172	42	6	226	3.20±0.65
July,1 to July, 20	11	15	204	52	8	290	3.10±0.53
July,21 onwards	2	9	164	10	--	185	2.98±0.42

The weight of freshly laid eggs varied from a minimum of 15.450 g to a maximum of 18.900g with an average weight of 17.212 ± 1.069g and varied in length from 34.5mm to 37.4mm (average 36.9 ± 0.50mm) and breadth from 26.3 to 27.6mm (average 27.4 ± 0.20mm). Average volume of the eggs calculated was 14.34 ± 1.80. The shape index of the eggs varied between 73.8 to 76.23 with a mean value of 74.23 ±0.475 (Table 4). The eggs showed a gradual weight loss of 16.6% on an average during incubation (Figure3). However, dimensions remained the same.

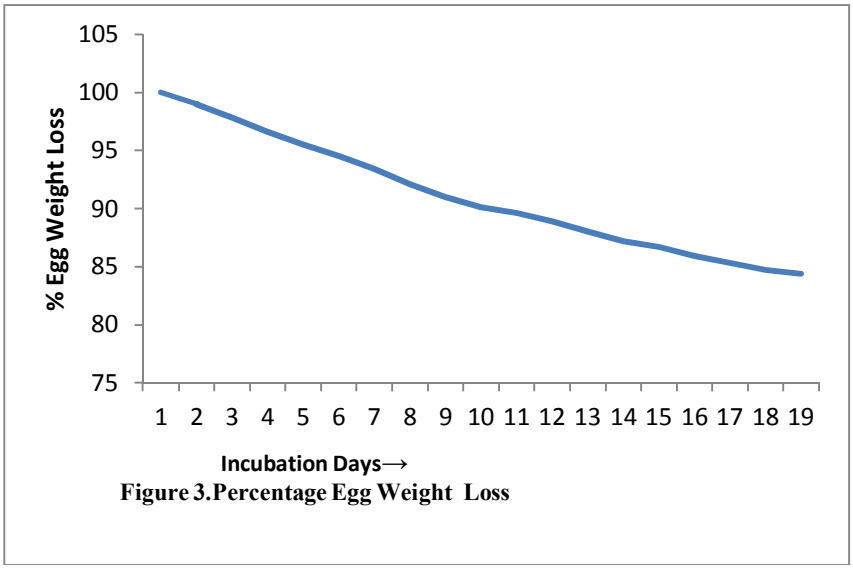

Figure 3.Percentage Egg Weight Loss

3.4 Incubation

The incubation usually started with the laying of first egg. Both members of a pair took part in incubation . During laying and incubation nests were attended by generally one of the parents and occasionally by both the parents when one was found waiting for the turn. The nests were hardly found unattended(n=29,time duration 5-37minutes).The time spent on incubation varied between male and female terns.

Table 4. Shape size and weight of eggs in Indian whiskered terns

	Min.	Max.	Mean ± S.D	Number measured
Weight of un-incubated eggs(g)	15.45	18.90	17.21±1.06	210
Weight of Incubated eggs (g)	11.20	15.55	14.35± 0.98	210
Length in (mm)	34.5	37.4	36.9 ± 0.50	200
Width in (mm)	26.3	27.6	27.4 ± 0.20	200
Volume (cm^3)	12.17	14.53	14.34± 1.80	200
Shape index	73.8	76.23	74.23 ± 0.47	200

Females incubated for longer period with an average of 41minutes and males for an average period of 27minutes during 25hrs and 38 minutes of observation on incubation (Table 5). Longest incubation period of 87 minutes was by a female and shortest of 13 minutes by a male. Of the 93 nest relief situations studied during incubation, the relieving bird landed near or on the nest platform near its outer margin 65 times and on the nest directly on 28 occasions. The direct landing was generally by the female while as male more often landed on the nest rim or in close visicinity of nest. The male was observed carrying fish or a snail and often feeding the female before relieving her off from the nest(n=31). At occasions male had to nudge off the female to take over the charge of incubation.

The incubating bird more often turned the eggs.Egg turning was observed throughout the day but more often during hotter parts of the day.During morning and evening hours the incubating bird sat practically calm and frozen on the eggs with occasional shifts of position. However, during hotter periods of the day the wings were kept half open to shade the eggs from scorching heat of sun and during rain the bird sat tightly over the eggs to protect them from cooling and dampness.

Table 5: Comparison of male and female whiskered tern nest attention during incubation.

Periods	Male	Female
Total observation time	**25hours 38 minute**	
Total attentive time	9hrs 48 min.	15hrs 50min
No. of attentive periods	22	23
Mean attentive periods	27min	41 min
Longest attentive period	3min.	87min
Shortest attentive period	3min.	21min.

The incubating bird during hotter-parts of the day performed thermo- regulatory behaviour during which beak was kept open and the throat rapidly vibrating. Incubation period varied from 20 to 23 days with an average of was 21.8 ± 0.88 days. (Table 6).

Table 6**:** Length of incubation period in Indian in Indian whiskered tern

No.of clutches observed	No.of Incubation Days				Mean Incubation period± S.D
	20	21	22	23	
45	5	8	23	9	21.8±0.88

3.5 Hatching and Hatching success

Hatching was asynchronous as the eggs hatched in the order in which they were laid. Their was variation in both inter and intra clutch hatching. It varied from a minimum of one to a maximum of two days that resulted in varied incubation periods.The appearance of cracks on the broader end near the pole indicated first sign of hatching but chick sounds were audible before the appearence of cracks.Due to continuous pipping the shell was broken and the membrane underneath became visible and the chick liberated itself without any parental assistance.The egg shells were removed by the parents by carrying them to a distance away from the nest in their beaks. Altogether 869 nests containing a total of 2748 eggs were studied during the course of investigation; 1053 from 322 nests in 2011, 1471 from 473 nests in 2012 and 224 from 74 nests in 2013 and over all hatching success of 28.82%was recorded.

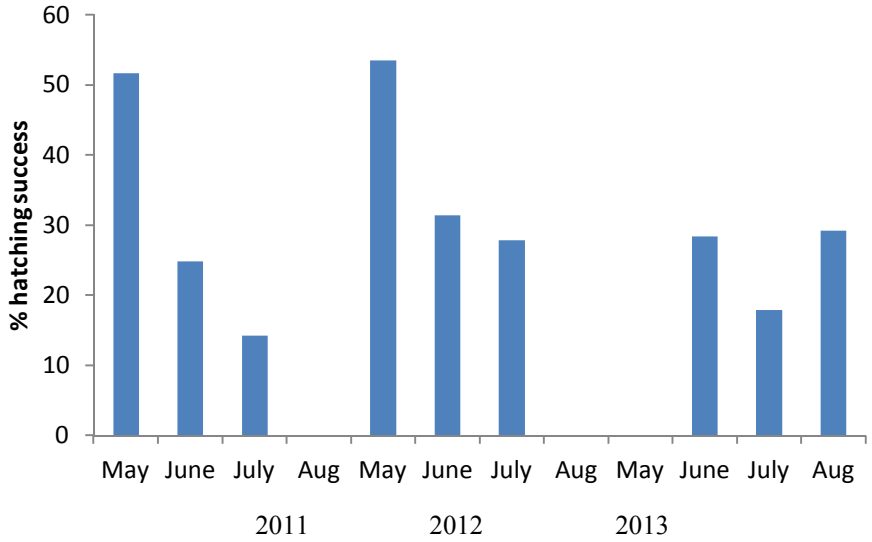

Figure 4. Annual hatching success in relation to month of laying

Though the overall hatching success remained very low yet highest of 31.75% hatching success was recorded during 2012. The lowest hatching success (23.2%) was observed during 2013(Figure 4). The eggs that were laid in different months highest hatching success of 52.43% was observed in those that were laid in May (Figure 4) and the lowest of 22.75% was observed in the eggs laid in July (Table 7).

Table 7: Overall hatching success in relation to month of laying.

Month	No. of Eggs	Eggs lost through predation		Eggs ost through faulty incubatio/ desertion		Hatching Success	
		No	%	No	%	No	%
May	309	141 141	45.63	6	1.94	162	52.43
June	1281	905	70.65	11	0.85	365	28.5
July	1134	870	76.72	6	0.53	258	22.75
August	24	16	66.67	1	4.17	7	29.17
Total	2748	1932	**70.31**	24	**0.87**	792	**28.82**

The factors that contributed to -low hatching success were predation, faulty incubation and infertility of eggs. In predation the higest loss was due to humans as they wiped away 68% of the eggs laid. Very low percentage of eggs were predated by common crow *(Corvus splendens),* pariah kite *(Milvus migrans),* night heron *(Nycticorax nycticorax)* and marsh harrier *(Circus aeruginosas).* As compared to predation a small percentage (0.87%) of eggs failed to hatch because of faulty incubation, infertility and death of embryos and desertion(Table 7).

3.6 Nestling and Nesting Success

Nestling survival during study was 0.25 and Nesting success calculated from exposure was 0.26(Table8). Of the 869 nests studied during three years of the study 596 (237in 2011,308 in 2012 & 51 in2013) were predated.In majority of the cases nests were predated during laying and humans were found major egg lifters as they generally preferred fresh eggs.

Table 8. Mayfield survival probability for different stages of Indian whiskered tern

	Exposure days	No.of eggs/Nestlings/Nests	No.of eggs/nests failed	Daily Survival	Success rate
Incubation	45096	2748	1957	0.95	0.34
Nestling	6504	792	695	0.89	0.25
Nesting	13590	869	596	0.96	0.26

4. Discussion

In most of the birds the entire breeding process is completed once in a year so that they are able to raise only one brood per year, but in some two or even three broods may also be raised (*Turdus marula*, Mayer- Gross and Perrins, 1962; *Ixobrychus minutus payesii*, Langley 1983). *Estrildine lagonosticta*, sengela raises four successive broods in about 9 months in each year in West Africa (Morel, 1964).In Indian whiskered tern (*Chlidonias hybrida indica*), the breeding season extended from May to August with the raising of a single brood only. Bates and Lowther (1952), and Ali and Ripley (1983) have also reported a single breeding season with the raising of one brood only for this tern from May to August in Kashmir. During 2013 the onset of breeding season was delayed till June. This delay by one month, in the onset of breeding season was probably due to unfavourable weather conditions. Due to heavy rains in April and May the whole lake was inundated as a result no favourable nesting sites were available and this led to the delay in the breeding season. Lack 1933, Gorenzal et al.,1981 Shah, 984 and Fazili,2010 have reported a similar situation during the period of inundation.

Factors that govern the breeding and migrational cycles of birds is an internal rhythm, under hormonal control and often modified to keep tune with prevailing environmental conditions. Day length appeared to be the chief external factor stimulating hormone flow and .recrudescence of the gonads, but favourable or unfavourable weather conditions as well as the availability of the right kind of food and suitable nesting sites can apparently modify the inherent internal rhythm (Wallace and Mahan, 1975). According to Lack (1960) the ultimate factor concerned with the timing of spring migration is the need for the birds to reach their breeding,grounds in time to take advantage of most favourable season.

A marked variation in the arrival time of the terns under observation was observed during the three years of observation. In 2011 and 2012 the terns were observed in the lake 0n 15th and 13th April respectively but in 2013 they landed at the lake in thelast week of April (27th April). The delay in the arrival time during 3rd year of observation seem to be due to the non availability of nesting sites and lack of right kind of food due to low temperature and lake deluge in March and April.

In Indian whiskered tern, pairs were established after performing certain type of displays like fish offering ceremony, strutting display and unique fighting patterns with rival males. These birds were monogamous as only one mate was retained in them throughout the breeding cycle. This was because of active participation for the successful rearing of nestling by both parents throughout breeding season. Wittenberger (1979) and Hunt (1980) have also reported that in sea birds including terns monogamy was predominant and both sexes play active role throughout the breeding season.

In many temperate species, onset of breeding season depends largely on the availability of nest sites and most of the aquatic birds often breed in relation to water level and suitable nesting material (Frith and Davies, 1958; Sugden, 1979 and Fazili,2010).

Lack of suitable nest sites may be a critical limiting factor in bird populations so after establishment of pair bonds, birds were observed engaged in selection of suitable nest sites that not only provided concealment and support to their nests but also protection to their nestlings from predators. Indian whiskered tern was observed to choose the nesting site in floating vegetation of *Nymphoides peltatum, Potomogeton lucense,, P. amphobium Trapa natans and Trapa bicipinosa* that had occasional growth of reeds generally *Phragmites communis* to hold the nest. The sites were either open or had thick rowth of either *Phragmites* or *Typha* at one side of the colony. These findings were inconsistence with those of Bates and Lowther (1952) Ali and Ripley (1983) and Shah (1984).

During most vulnerable period in the life cycle, birds construct their nests to protect themselves. their eggs and particularly their developing young from predators and from adverse weather conditions (Welty, 1979). Terns exhibit varied nesting habits, the fairy elegant tern places the single egg on horizontal branch of a tree with no nest material to hold it; Caspian tern and Indian river tern form a shallow scrape in the sand; Tibetan common tern, a simple depression amongst dried weeds and grasses and occasionally a mere scrape amongst pebbles; rosy and white cheecked tern a simple depression in sand lined with debris, bits of twigs or grass stems, eastern black naped tern a skimy bed of coral fragments and Indian whiskered tern a floating pad of water lily stems and decaying rushes on *Trapa* (Ali and Ripley, 1983). Karwowski, et al. (1995) have observed that common terns construct nests on navigational aids. Bates and Lowther (1952) have reported that a simple platform of water reeds and lily stems on floating vegetation with the centre or middle sufficiently large enough to hold eggs of Indian whiskered tem that are found in colonies. Shah,1984 has reported that Indian whiskered terns nest in colonies and nests are rough circular pads of reeds and rushes on floating vegetation of *Trapa natans.* Nest structure observed during present investigation resembles to the findings of Bates and Lowther 1952, Ali and Ripley1983 and Shah, 1983. Both sexes took active role in nest building, males generally collected nesting material and the females arranged the material on the nest.

So it falls in category 2 of Ryves (1944) classification. Nest building was initiated in early May and majority of nests were completed between 3 to 7 days before laying was initiated in them. So far as the elaborateness of the nests was concerned, the terns were fast workers, building in a short periods of 3 to 7 days only as compared to goldfinch (13 days for July and 5 to 6 days for August; Stokes,- 1950). The gradual and seasonal colour changes in the bill and soft parts in Indian whiskered tern have been well documented (Wiles and Worthington, 1996). During present study the bill and leg colour of terns tirned red during breeding.It seemed probably because of secretion of hormones which stimulate breeding activities in both the sexes.

In Indian whiskered tern, Bates and Lowthcr (1952) have shown that the eggs vary considerably in ground colour from grey to greenish and some have shade of yellowish brown with equally variable markings of either deep chocolate or purplish brown colour. The eggs have no gloss and average size was 37.0 x 27.4mm. Ali and Ripley (1983) have reported that eggs of whiskered terns are variable in colouration and markings both as to clutches and individual eggs in same clutch. A common type is some shade of sea green, blotched and speckled with brown. Average size of 200 eggs was 36.9 ±0.5 x 27.4 ± 0.2mm (Baker in Ali and Ripley, 1983). During present study the morphometries of 200 eggs of Indian whiskered tern were found in accordance with the earlier findings of Baker in Ali and Ripley (1983). Coulson and Horobin (1976) have shown the egg dimensions of known aged Arctic terns ranged between 39.8 - 41.3mm in length and 28.7- 29.4 mm in breadth while as Whittam (1998) have reported that mean egg measurements of Arctic tern, roseate tern and their hybrids were 41 x 30 mm, 43 x 30 mm and 49 x 28 mm respectively. The smaller size of eggs of Indian whiskered tern seemed to be due to species variation, female's health condition and age in addition, to varied physiological and environment conditions.

In Indian whiskered tern the clutch size ranged from I to 5 but in majority of nests 3 egg clutches were generally found (645 nests out of 869). Variation in the clutch size seems to be due to the variation in age of females that may have direct influence on the laying of these birds. Coulson and Horobin (1976) reported significant difference in the mean clutch size in Arctic tern, *Sterna paradisa.* The clutch size was lowest in the youngest and old aged groups and maximum in 6 to 8 year old age group. An increase in clutch size with age has also been found in kittiwake gull (Coulson, 1966). Bates and Lowther (1952) have reported 3 egged clutches in 67 nests in Indian whiskered tern in Kashmir. Ali and Ripley (1983) have noted 2 or 3 eggs per clutch. Buckley and Buckley (1972) have recorded generally one egg clutches and rarely 2 egg clutches in royal terns.Among common terns, Karwowski, et al.(l995) have shown a modal clutch size of 3 eggs but 4 egg clutches were also reported. Bollinger (1994) has also reported clutch size of 3 eggs among 70% in common terns and 2 egg clutches in 22% terns.

Both the sexes in Indian whiskered tern took part in incubation and it was initiated soon after laying of first egg. The incubation period observed ranged from 20 to 23 days with an average period of 21.8 ± 0.88days. Incubation by both the sexes is a common feature among terns as reported by Bates and Lowther (1952), Ali and Ripley (1983), Buckley and Buckley (1972), Bollinger (1994), Whittam (1998) Karwowski el al. (1995) but Wiggins and Morris (1987) have reported 16- 23 days of incubation period.

During the incubation there is loss in egg weight probably due to evaporation, which increases with continued incubation and with rising temperature. In present studies there appeared a gradual loss of about 16.6%.Shah (1984) has recorded a loss of 10.5% in the egg weight in moorhen and Bibby(1982) recorded in cetti's warbler that eggs lost weight linearly according to y= 207- 0.022d, where d= days from clutch completion. Irrespective of size, eggs generally lose between 15 to 18% of their initial mass as water as incubation proceeds till hatching(Brown,1994).Female Indian whiskered tern had significantly higher attentive period of incubation during 25 hours and 38 minutes of observation. Similarly higher incubation rates by females have been observed in Arctic tern (Wiggins and Morris 1987). The higher attentive periods by female during the incubation and egg formation at the nest could be probably due to the continuous feeding of the female by male and allowing the female to spent considerable time at nest..

Incubating Indian whiskered tem during hotter parts of the day performed their thermo regularity behaviour during which the beak was kept open and throat rapidly vibrating. This behaviour has been found more often in gulls and terns (Bartholomew and Dawson 1952, MacRoberts and MacRoberts 1972). In Indian whiskered tern males were observed offering fish or squad to the females during nest relief. Such an activity has also been reported in common terns (Palmer 1941).

Hatching was asynchronous as the eggs hatched in the order in which they were laid, because incubation started prior to the completion of the clutch either just alter laying of first egg or after laying of 2nd egg.Asynchronous hatching in terns has earlier been reported by Nisbet (1973) and Nisbet and Cohen, (1975). The hatching success varied greatly from a minimum of 14.24% to a maximum of 53.44% with an

average of 28.82%. The hatching success was more related to the habitat condition and experience of the incubating birds. The main reason for low hatching success in terns could be due to their exposed nests that were most vulnerable to human and avain predation in addition to the losses due to high fluctuation in water table. Fazili *et al* (2013) has also reported low hatching success in Pheasant tailed jacana due to exposed nature of its nests. Nestling survival during study was 0.25 and nesting success calculated from exposure was 0.26.Low survival rates were mainly due to high effect of predators and the exposed nature of nests and nestlings.

Conclusion

Indian whiskered tern a regular summer migrant to the valley's wetlands completes its breeding cycle within a spain of four months but suffers a heavy loss at the hands of humans who mostly destroy their colonies during the critical period of breeding. If this menace remains unchecked the population will lead to extinction. Proper conservation measures need to be taken for the safe and long term survival of this bird species which has important role in the wetland ecology as it constitutes an important trophic level in the food chain of aquatic ecosystem. Any measure deviation in this bird population will be detremental to the health of the wetlands.

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Corresponding Author

Mustahson Farooq Fazili
Wildlife Research Division,
Postgraduate Department of Zoology,
University of Kashmir, Hazratbal
Srinagar-190006, Kashmir.
drfaziliwl@yahoo.com

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