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NESTING ECOLOGY, BREEDING BEHAVIOUR AND FACTORS AFFECTING OVERALL BREEDING SUCCESS OF ACRIDOTHERES TRISTIS: COMMON MYNA IN SOUTHERN LANDSCAPE OF KASHMIR VALLEY, INDIA

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Abstract

The height of the nest of common myna was found to vary between 3-8m (5.5±1.04) in the selected transects under study. The nesting success rate was found to be prominent for those nests which were located at an elevated height in all the transects under study. It was observed during the study period in the selected transects that common mynas initiate bonding in early part of spring season and before the finalization of the territories which is preceded by high scale competition for acquisition of suitable nesting sites. Cavity nests were majorly preferred than the natural sites across transects under study. When the weight of nests of common myna in the selected transects was compared using ANOVA , differences in weight of nest of nests between transects was found to be significant and thus led to rejection of null hypothesis(H_o) .The F distribution value was found to be 9.416 , and is higher than the Fcrit (3.490) and thus validates rejection of null hypothesis .The probability value came to be p-value =0.001 (p-value <0.05) which is an indication of significant difference in the weight of nests in different transects of the study area. The correlation coefficient between the nest width and depth in case of nests found in holes and crevices of concrete walls came to be *r=0.9* which signifies a significant positive correlation between these two variables .The p-value came to be p-value=0.0009 (p-value<0.05) and thus validates rejection of null hypothesis (H_o**)**.The correlation coefficient between the nest width and nest depth in case of open ,rounded and cup shaped nest was found to be ***r=***0.87 and thus indicates positive correlation between these two variables. .The weight of newly laid eggs ranged from 7.0 to 8.5g and averaged 7.6± 0.1(mean± S.E, n=14). The differences in the average weight of successive eggs was found to be non-significant on applying ANOVA to verify Null and alternate hypothesis (F= 2.10, *df*= 3, 10, *p*=0.16(p> 0.05), *Fcrit*= 3.70). As the p-value is > 0.05, it validated null hypothesis and upholds that there is no significant differences in the average weight of successive eggs .This is equally evidenced by the value of *F (2.10)* which is lower than the *Fcrit value (3.70*) and is an indication that no significant difference exists and thus does not reject null hypothesis. In all the transects under study , it was observed that the clutch size of common myna ranged between 3 to 4 eggs but clutch size of 3 eggs were more in sight **.** The clutch size of first brood was observed to 3.5±0.22 (n=6), of second brood 3.5±0.28 (n=4) and of third brood was found to be 3.33±0.33 (n=3) and showed no significant difference between the successive broods. The incubation period varied slightly among the transects and was found to range between 11-13 days averaged 12 ± 0.57 dS.E in transect Ⅳ, which is an urbanized transect and is characterized by higher ambient temperature.

Keywords: Acridotheres Tristis, Clutch Size, Brood, Incubation Period, Hatching, Fledging Period, Fledgling Success Rate.

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INTRODUCTION

Acridotheres tristis (common myna) normally mates for life. The common myna prefers to remain in the same breeding pair and mostly establishes same territory year after year. There is usually large scale competition for nesting sites during the breeding season. The *Acridotheres tristis* is dominant species among avifauna in the southern landscape of Kashmir valley. It is regarded as one of most invasive avian species in the word. *Acridotheres tristis* belongs to family Sturnidae (Starling family). It appears brown with brown head. During flight, wings bear white patches. The bill and the legs are yellow in color. The weight of common myna varies between 87-149 grams and the length ranges between 24-29 cm and has a wing span of 118-144 mm. The average life expectancy of common myna is believed to be 4 years .The common myna is capable of thriving in any sort of habitat and have thereby became invasive species The common myna's overall success is largely attributed to its aggressive and opportunistic behavior towards other birds and is usually found over powering other birds around feeding sites and eliminates them from nesting sites as well. The IUCN Special survival commission declared it among the top 100 damaging invasive species (Lowe et al .2004).Common myna inhabits diverse habitats and its presence ranges from Bangladesh, India , Pakistan , Iran , China (Ali et al.2001). It has been successfully introduced in other regions such as New Zealand, Australia, South Africa etc. (Auduban Field guild 2016). Selecting an appropriate nesting site is regarded as an inevitable and decisive factor for potential reproductive success in avifauna species and birds likely prefer those nesting sites that ensure round the clock protection of their nests from extreme weather events and predators(Liebe zeit and George (2002) , Marshall and Cooper (2004) Ali and Santhanakrishan 2005)

MATERIALS AND METHODS

The nesting activities and breeding parameters of predominant birds were observed on weekly basis in all the designated transects during the study period (February 2021-August 2022 .During peak nest building and reproductive activity , frequent visits were also organized as per the need so as to get conclusive evidences pertaining to breeding parameters of predominant birds .The core parameters that were taken into account during the field visits included nest designing , nature and type of nesting material ,number of eggs laid , hatching success , fledging success and over all breeding success .For smooth facilitation of collection of data the Nikon P510(44X Zoom 16 MP) camera was employed to capture photographs while maintaining a safe distance without disturbing the birds or their nest. The photographs were properly labelled using Microsoft paint software. During the entire survey period, it was ensured that only the photographs of predominant birds, their nest and hatchlings were taken. To examine the nesting ecology of predominant birds in the designated transects under study, the data was acquired through various means including general observations, bird watching methods, trekking method. Expertise help too was considered at times from local bird lovers and environment enthusiasts to further consolidate and concretize the data so as come to a unanimous conclusion in terms of data manipulation.

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To note down the observations of open or cavity nests located above 4 meters a wooden linear ladder was used. The dimensions of freshly laid eggs was sorted out by using different devices such Vernier calipers were employed to measure egg length and width and electronic balance was used to weigh the freshly laid eggs.

To get an exact and accurate understanding of breeding parameters such as egg laying sequence , incubation period , hatching trend , fledgling period and over all breeding success minutest observations were recorded in an orderly pattern and the expertise services of bird keepers was also taken seriously to double ensure that authentic data is recorded without any ambiguity.

The nesting sites selected for observation of breeding parameters were marked with red colour ink prior to initiation of egg laying process and this was done to ensure that observations pertaining to different phases of breeding cycle are recorded with accurate precision without missing any phase. During the time of peak breeding activity , nests were monitored on regular basis at the time of egg –laying stage, thrice a week after completion of clutch and there after again on regular basis near the arrival date of fledging. The fledging dates were maintained by taking daily observations of the nest.

RESULTS

Breeding season

During the breeding season they were found to be strongly territorial and the adjacent breeding pairs were often seen involved in fierce fights over nesting site possession The common myna initiated breeding activity in March across transects under study except in transect I , where initiation of breeding started a bit later as the transect is a forest dominated transect and had unfavourable weather conditions which led to unavailability of suitable nesting sites in the initial part of March month . The breeding activity extended till September. It is quite evident that breeding season of common myna is long, spanning over a period of more than six months from March to September. The myna were observed actively involved in nesting building process and started adding diverse nesting material to the selected nesting site in the initial days of March month.

Courtship and Mating

Common myna is territorial monogamous .It was observed during the study period in the selected transects that common mynas initiate bonding in early part of spring season and before the finalization of the territories which is preceded by high scale competition for acquisition of suitable nesting sites . The male displays the courtship by head bowing and bobbing, spread out plumage and subsequently accompanied by mating calls.

Nesting

Common myna preferably used leaves and twigs of *Cupressus sempervirens*, *Pyrus malus*, and *Salix alba*, plastic, feathers, paper, Junk food wrappers. The nest was not having any particular design and shape of the nest was decided by the space of the cavity

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in which the nests were made. The preferred location for nesting sites includes cavities in the walls and ceilings of the concrete buildings, inside aeration pipes. Nests were also found in natural tree cavities, used by other birds. Common myna opted for those sites to build their nests which were richly occupied by trees and buildings rather than crop fields, orchards, grassy lands. Cavity nests were majorly preferred than the natural sites across transects under study. The preference of cavity nests over natural nesting sites seems to be well thought out strategy by common myna as cavity nesting such as building holes, hollow pipes, tree holes facilitate common myna by providing narrow range conducive climatic conditions for eggs and hatchlings and also minimize risk of predation to nests. Nests were found to be messy and in disarray without proper alignment and sequential setting of the nesting material .In cavity nest building, the nesting material was deposited in and around the entrance site for first couple of days in order to reduce dimensions of entry junction and thus facilitate the check of predator access to the interior of the nest. The internal nest building process was seen to be initiated on day fourth and the most prominent feature was displayed by aligning the green leaves in the central part of the nest so as to render the egg laying surface smooth .Nest building usually lasted for 7-9 days, based on the observation of 16 nests, four from each transect under study. Nest material examination revealed that the easily accessible materials were mostly preferred by the common myna. In all the transects. The predominant plant based material used in the nest building by common mynah in the selected transects of southern landscape of Kashmir valley was primarily determined by the type of vegetation found in the transect. In total 16 nests, four from each transect were chosen for investigation. Their nesting material was sorted and subsequently weighed. Plant based nesting material like leaves and twigs were employed in nesting building in predominantly greater proportions than non –plant based materials such as wrappers, paper, feathers, fabric threads etc.

Nest height

The height of the nest of common myna was found to vary between 3-8m (5.5±1.04) in the selected transects under study. The nesting success rate was found to be prominent for those nests which were located at an elevated height in all the transects under study. The nesting site selected at an elevated height had definitely a competitive edge over a nesting site selected at a lower height in terms of safe and secure passage from the predators and the anthropogenic disturbance. In Transect Ⅲ, nests build by common myna in close proximity of the human habitation especially the open nests were observed to be increasedly more prone to anthropogenic disturbances as the open nests are more prominent and visible than the cavity or hole nests and thus are at an increased risk of predation .In transect Ⅰ, which is densely occupied by varied vegetation ,majority of nests were observed in tree cavities as the transect has sparse human settlements and were observed to be at reduced risk of predation than open nests ,though being built at a lower elevation.

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Table 1: Weight and height of nests of common myna in selected transects of Southern landscape of Kashmir valley

Transect	No. of nests analyzed for weight.	Weight (g)of the nests		Height(m) of the nest	
		Range(g)	Mean±S.E	Range	Mean±S.E
Ⅰ	4	38.63-49.7g	44.63±2.36	3-8 m	5.5±1.04
Ⅱ	4	28-36	31.7±1.81	3- 7.5m	5.67±0.84
Ⅲ	4	34-47.6	40.87±3.11	3-7m	5 ±1.82
Ⅳ	4	44.6-53	48.32±1.74	3-7m	5.5±0.64
Statistical Analysis		ANOVA *F*=9.416, *Fcrit* =3.490 *Df=3,12* *p-value=0.001* *(P-value<0.05).* *Statistically significant difference in the weight of nests of common myna in different transects under study.*		ANOVA *F= 0.11 Fcrit=3.49* *Df=3, 12.* *p-value =0.95* *(p-value >0.05)* *Statistically non-significant: No significant difference in the height of nests of common myna in different transects under study.*	

When the weight of nests of common myna in the selected transects was compared using ANOVA , differences in weight of nests between transects was found to be significant and thus led to rejection of null hypothesis(H_o) .The F distribution value was found to be 9.416 (Table 1), and is higher than the Fcrit (3.490) and thus validates rejection of null hypothesis .The probability value came to be p-value =0.001 (p-value <0.05) which is an indication of significant difference in the weight of nests in different transects of the study area .The analyzed data establishes that the type of habitat had a strong influence on the weight of nests of common myna .On comparing the height of nests of common myna in the different transects under study using ANOVA , the differences in the height of nests in different transects was found to be non-significant as is evident from the values of different attributes of ANOVA. The value of *F* distribution came to be 0.11 (Table 1) which is lower than the Fcrit (3.49) and thus validates or accepts null hypothesis .The p-value came to be 0.95 (p-value >0.05) and is thus an indication that there is no statistically significant difference in the height of nests of common myna in the selected transects and also corroborates the acceptance of null hypothesis.

Nest shape and size

The shape of the nest of common myna in the selected transects was mostly determined by the selected nesting site. The nests build by common myna on trees and open spaces were more or less cup shaped and round in shape**.** The nests built in the crevices and holes of concrete walls were elongated in shape length wise with comparatively smaller diameter. In transect Ⅰ, where tree hole nesting is predominant, the common myna used the natural cavities of tree trunks as prime nesting sites. The nesting dimensions such as width and depth varied significantly depending upon the nesting site. The

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entrance width and depth of holes and crevices in concrete buildings used by common as a nest varied between 8-15cm (11.5± 0.86) (Table 2) and 17-34cm (25.5± 1.25). The entrance width and depth of open rounded and cup shaped nests ranged between 11-19 cm(15±0.91) and 8-16 cm(12±0.91).The entrance width and depth of tree holes varied between 5-11cm(8±0.81) and 11-33cm (22± 1.41) .

Table 2: Size dimensions of different types of nests of common myna in Southern landscape of Kashmir Valley

Study area	Width and depth of nest found in holes and crevices of concrete buildings.		Width and depth of open rounded cup shaped nests.		Width and depth of natural tree holes used as nest by common myna.	
	Width (8-15cm)	**Depth (17-34 cm)**	**Width (11-19cm)**	**Depth (8-16cm)**	**Width (5-11cm)**	**Depth (11-33cm)**
Southern landscape of Kashmir valley	Mean± S.E 11.5±0.86 cm	Mean±S.E 25.5±1.25cm	Mean±S.E 15±0.91cm	Mean±S.E 12±0.91	Mean±S.E 8±0.81cm	Mean±S.E 22±1.41cm
Statistical Analysis Pearson's Correlation Coefficient.	*r*= 0.9 p-value =0.0009 p-value<0.05 Significant positive correlation between the variables		*r* =0.87 p-value =0.002 p-value<0.05 significant positive correlation		*r* =0.88 p-value=0.001 p-value<0.05 Significant positive correlation between the two variables	

Pearson's correlation coefficient was employed to establish the correlation between the variables of nest width and nest depth. The correlation coefficient between the nest width and depth in case of nests found in holes and crevices of concrete walls came to be *r=0.9 (*Table 2) which signifies a significant positive correlation between these two variables. The p-value came to be p-value=0.0009 (p-value<0.05) and thus validates rejection of null hypothesis (H_o**)**.The correlation coefficient between the nest width and nest depth in case of open ,rounded and cup shaped nest was found to be ***r*=**0.87 and thus indicates positive correlation between these two variables . The p-value in this case was found to be 0.002 (p-value <0.05) (Table 2) which establishes the rejection of null hypothesis (H_o**)**. and acceptance of Alternate hypothesis (H_a**)**that there is significant correlation between these two variables .The Pearson's correlation coefficient between the nest width and nest depth in case of natural tree holes was found to be *r*=0.88,which is an indication of significant positive correlation between these two variables . The p-value came to be 0.001 (p-value <0.05) (Table 2) which establishes acceptance of alternate hypothesis (H_a**)** and rejection of null hypothesis (H_o)

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Eggs

The eggs of common myna observed in the selected transects of the study area were elliptical or oval in shape and length wise longer and breadth wise shorter. The eggs of the same clutch even showed slight variation in shape. The eggs had characteristic turquoise –bluish color .The weight of newly laid eggs ranged from 7.0 to 8.5g and averaged 7.6± 0.1(mean± S.E, n=14) . In all the transects except transect Ⅱ, The weight of subsequent eggs laid in the clutch showed reduction in weight but in transect Ⅱ, The weight of 2nd and 3rd eggs of the clutch was higher (7.8g) as compared to weight of the first egg of the clutch(7.5g). It was also observed that the average weight of eggs in individual clutches transect wise varied from 7.4±0.2(Transect Ⅲ) to 7.9±0.2 (transect Ⅳ).The higher weight of eggs in transect Ⅳ is largely attributed to abundance of majorly unhygienic food resources as the transect is a highly urbanized transect and is characterized by the presence of novel food items like leftover food from hotels and restaurants , heaps of garbage sites which were seen as major food attraction sites for common myna . The differences in the average weight of successive eggs was found to be non-significant on applying ANOVA to verify Null and alternate hypothesis (*F*= 2.10, *df*= 3, 10, *p*=0.16(p> 0.05), *Fcrit*= 3.70). As the p-value is > 0.05, (Table 3) it validated null hypothesis and upholds that there is no significant differences in the average weight of successive eggs .This is equally evidenced by the value of *F(2.10)* which is lower than the *Fcrit value (3.70)* and is an indication that no significant difference exists and thus does not reject null hypothesis.

Table 3: Weight of eggs of common Myna Transect wise

Nest No.	Transect	Weight of eggs(g)				Mean±S.E
		Egg Ist	Egg 2nd	Egg 3rd	Egg 4th	
1	Salia	8	7.5	7.5	7.0	7.5±0.2
2	Anchidora	7.5	7.8	7.8	-	7.7±0.1
3	Akura	7.8	7.5	7.0	Broken	7.4± 0.2
4	Lal Chowk	8.5	7.8	7.8	7.5	7.9± 0.2
Mean± S.E		7.95±0.21	7.65±0.08	7.52±0.18	7.25±0.25	7.6±0.1
ANOVA		*F*= 2.10, *Fcrit*= 3.70 *df*= 3,10 , *p*=0.16(p> 0.05), As p-value is greater than 0.05 , there is no significant difference in the average weight of successive eggs and thus validates acceptance of null hypothesis (H_o)				

The length of eggs varied among transects .The maximum length of eggs was found in transect Ⅳ and averaged 23.49± 0.31 and minimum length was observed of eggs found in transect Ⅲ and averaged 21.98± 0.04 (Table 4).

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Table 4: Morphometric variables of eggs of common Myna in selected transects

Location	Transect	Egg weight (gm)		Egg length(mm)		Egg width(mm)	
		Range	Mean±S.E	Range	Mean±S.E	Range	Mean±S.E
Southern landscape	1	7-8g	7.5±0.2	22-23.5	22.75 ±0.32	16.09-17.0	16.62±0.20
	2	7.5-7.8	7.7±0.1	22.5-24	23.33±0.44	16.5-17.07	16.75±0.16
	3	7.0-7.8	7.4± 0.2	21.9-22.05	21.98±0.04	15.9-16.03	15.97±0.03
	4	7.5-8.5	7.9± 0.2	22.9-24.06	23.49±0.31	16.9-18.0	17.55± 0.25

Influence of habitat on morphometric variables of eggs

The data pertaining to morphometric variables of eggs of common myna was collected from all the four transects under study which in fact represent four diverse habitats viz forest dominated habitat , Riverine and industrialized habitat, Agrarian habitat and Urbanized habitat. The type of habitat had an impact on the morphometric variables of eggs of common myna. The eggs observed in the transect Ⅳ were found to be broadest with average width 17.55± 0.25mm (Table 4) and heaviest with average weight 7.5-8.5g. Egg width was found to be smallest with average width 15.97±0.03mm and egg weight with average weight 7.4± 0.2 g was observed in case of eggs collected from transect. The prominent factor attributed to increased egg size dimensions in transect Ⅳ is probably higher abundance of food resources as the transect is highly urbanized transect.

Influence of egg laying sequence and brood number on morphometric variables of eggs of common myna

The consecutive eggs of the clutch exhibited no significant difference (Table 5) in their size when the data was statistically examined using ANOVA .Likewise on comparing the size of eggs of first and second brood, statistically by employing ANOVA , no statistically significant difference was found between the broods and thus resulted in acceptance of null hypothesis (H_o).The egg laying sequence had no influence the on weight, length and breadth of eggs and the eggs showed no significant difference when the data was subjected to statistical analysis using ANOVA. For weight of egg, the p-value came to 0.16 (Table 5) which is greater than 0.05(p-value> 0.05) .Likewise for length and breadth, the p-value was found to be p-value -0.19 (Table 5) and p-value 0.78(p-value >0.05) respectively .As the p-value in all the cases is > 0.05 , it validates the acceptance of null hypothesis(H_o)

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Table 5: **Impact of egg laying sequence on Egg size dimensions weight, Length and breadth**

Egg laying sequence	Sample size	Weight	Length	Breadth
First egg	4	7.95±0.21	23.08±0.35	16.36±0.25
Second egg	4	7.65±0.08	22.85±0.23	16.43± 0.50
Third egg	4	7.52±0.18	22.34±0.24	16.32±0.53
Fourth egg	2	7.25±0.25	21.88±0.82	16.01±0.01
		F-Value=2.10 *Df=3,10* *p-value – 0.16* *p-value > 0.05* *No statistically significant difference*	*F-Value=1.85* *Fcrit=3.85* *Df= 3,11* p-value- 0.19 P-value> 0.05. Statistically non-significant.	*F-Value=0.35* *Fcrit= 3.70* *Df=3,10* *p-value=0.78* *p-value> 0.05* *Non-significant.*

Clutch size

In all the transects under study , it was observed that the clutch size of common myna ranged between 3 to 4 eggs but clutch size of 3 eggs were more in sight **.** The clutch size of first brood was observed to 3.5±0.22 (n=6) (Table 6), of second brood 3.5±0.28 (n=4) and of third brood was found to be 3.33±0.33 (n=3) and showed no significant difference between the successive broods. (Table 6). On subjecting the data to statistical analysis using ANOVA to ascertain if clutch size exhibits any significant difference between the successive broods and subsequently validate or reject null hypothesis. The value of F= *0.101*(Table 6*)* was found to be lower than the *Fcrit=4.10,* which validates acceptance of null hypothesis .It is equally validated by *p-value =0.90 (p-value>0.05)* and thus verifies that there is no significant difference between successive broods and clutch size.

Table 6: Influence of successive broods on clutch size

Brood no.	Clutch size Mean ±S.E	Sample Size	Statistical Analysis(ANOVA)
1	3.5±0.22	6	*F= 0.101* *Fcrit= 4.10* *p-value =0.90* *p-value> 0.05* *Statistically no significant difference and thus no rejection of null hypothesis.*
2	3.5±0.28	4	
3	3.33±0.33	3	

Incubation and Hatching:

In all the transects under study, the incubation period was observed to range between 11-15 days with average 13d±0.70 d S.E (Table 7)**.** The incubation period varied slightly among the transects and was found to range between 11-13 days averaged 12 d ± 0.57 S.E in transect Ⅳ, which is an urbanized transect and is characterized by higher ambient temperature .Temperature catalyzes incubation and results in its early successful

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completion .Among all the four transects under study, higher incubation period of 12-15 days averaged 13.5± 0.64d was observed in transect Ⅰ, which being a forest dominated transect has comparatively lower ambient temperature than other three transects. Lower temperature was found to prolong incubation period. The nests of common myna in transect Ⅳ had an increased accumulation of plastic and polyethene ingredients which act as an insulating material and thereby raise the temperature of the egg chamber of the nest and contributes in the early accomplishment of incubation of eggs. In the designated transects ,females were observed to lay 3-4 eggs per clutch , but the clutch size of 3 eggs were frequent in sight. The incubation job was not sex specific and in fact both the parents were seen to take alternate turns of specific time duration to execute the job of incubation. During the early stage of incubation, the sitting bouts lasted longer and usually went up to 13 minutes .Gradually the duration of incubation bouts reduced and usually lasted for 5-8 minutes in the middle part of the incubation and 2-5 minutes at the terminal end of the incubation .The females were observed to incubate the most part of the time and were also seen to incubate the eggs all alone at night and males normally participated in incubation during the day. Eggs were normally seen to hatch in an orderly sequence and at almost 22-24 hour intervals .The hatching success rate varied significantly among the transects and was found to be highest in transect Ⅱ(Figure 1)with a success rate of 66.66%(n=8)(Table 7) and lowest in transect Ⅳ with a success rate 53.33(n=8) .The obvious reason of decreased hatching success in an urbanized transect (Transect Ⅳ) is affected by multitude of reasons and one of the predominant factor was the predation of eggs of common myna by Corvus splendens (House crow) and the physical damage to the eggs as a result of their rolling down of from a height and the rampant anthropogenic interference in dismantling the nests of common myna laden with eggs. These factors collectively contributed in scaling down the hatching success in comparison to other transects, where the prevalence of these factors was observed to be in less severity. The newly hatched young ones were found to be underdeveloped, naked and blind and are not capable to feed or care for themselves and are unable to move of their own after. The newly hatched young ones were initially given insect rich diet during first 4-6 days and subsequently large sized insects and earthworms from 7th or 8th day onwards .However plant based was not given to young hatchlings before 10th day. The feeding rate varied greatly as the time passed by and was observed to be 6-12 times per hour in the initial week after hatching and thereafter varied between 12-17 times per hour for the next two weeks .It was observed that the recently hatched nestlings exhibited vigorous growth in the initial 4-6 days after hatching and then showed a gradual decline in growth rate .The rate of growth of nestlings was observed to be constant for each nestling but some differences were witnessed between nestlings of the same brood. The first hatchlings exhibited enormous growth than the subsequent hatchlings and thus exhibited variations in mass among different nestlings of same brood. The newly hatched young ones roughly attained highest growth at the age of 15-16 days and there after witnessed abrupt decline till the initiation of fledging .It was quite evident from the observation of growth pattern of hatchlings that it followed a sigmoidal curve of growth pattern Both parents were actively

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seen feeding their young ones for round about 22 days or more. Both the partners were seen taking food in their beaks to feed the hatchlings .The parents were seen making frequent to and fro visits to nests to deliver food brought by them to the hatchlings and the visits were normally segregated by 2-4 minute interval. It was also revealed by the current study that if both the parents brought the food at the same time ,then only one parent was seen entering the premises of the nest and the other parent waited for his/her turn to enter the nest premises with food to feed the hatchlings during his turn. The parents were observed investing feeding more to older hatchlings than their younger counter parts because the older hatchlings have increased nutritional demand and they were also seen begging more vociferously for food than the younger ones. Unlike blue rock pigeon, they do not possess crop and thus were seen carrying food in their beaks and feed the young ones instantly with the food.

Nestling period

Nestling period is considered as the period between hatching of egg to the day the nestlings leave the nest. Nestling period varied between 18-30 days and averaged 24± 1.08 in the selected transects. The nestling period of first couple of hatchlings was observed to be much smaller than that of the last two nestlings. It indicates that the earliest hatched young ones although were capable of leaving the nest early but they wait for other nestlings to simultaneously fledge out successfully. This ensured that all the nestlings exit the nest together with their parents. The obvious reason seemed to be that the young ones are to be cared and protected on the foraging ground and parents cannot afford to leave the young ones unprotected on the foraging ground to go back to the nest to feed the left out nestlings in the nest.

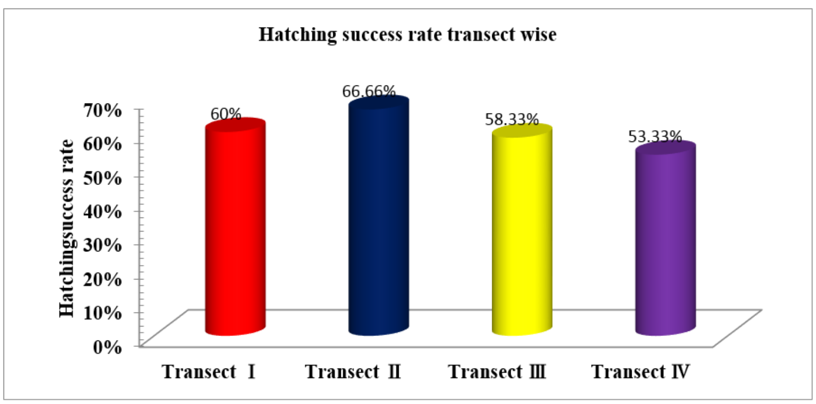

Figure 1: Hatching success rate in selected transects of southern landscape of Kashmir Valley

Fledging

The fledging period in the selected transects under study ranged between 18-30 days and averaged 24± 1.08.The fledging period differed significantly among the transects as the four designated transects represented four diverse habitats and were characterized

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by prevalence of different set of environmental factors .Fledging period of shorter duration was observed in the transect Ⅳ and was found to range between 18-25 days averaged 21.5±0.86(Table 7) .Fledging period of longer duration was observed in transect Ⅰ and was found to range between 19-30 days averaged 24.4±1.04 .The shorter fledging period in an urbanized transect is probably attributed to sufficient abundance of food for proper nutritive nurturing of the fledglings to transform them into active fledglings capable of early adaptation of flight and obviously the higher ambient temperature in the said transect also played a vital role in early fledging of fledglings . The unfavourable weather conditions especially the cold temperature in the forest dominated transects delayed the fledging of fledglings and the scarcity of food resources also significantly contributed in the prolonged fledging period in the said transect. The fledging success rate of 62.5% (n=5) was found to be highest in transect Ⅱ (Figure 2) and lowest in transect Ⅳ with a success rate of 50% (n-=4).

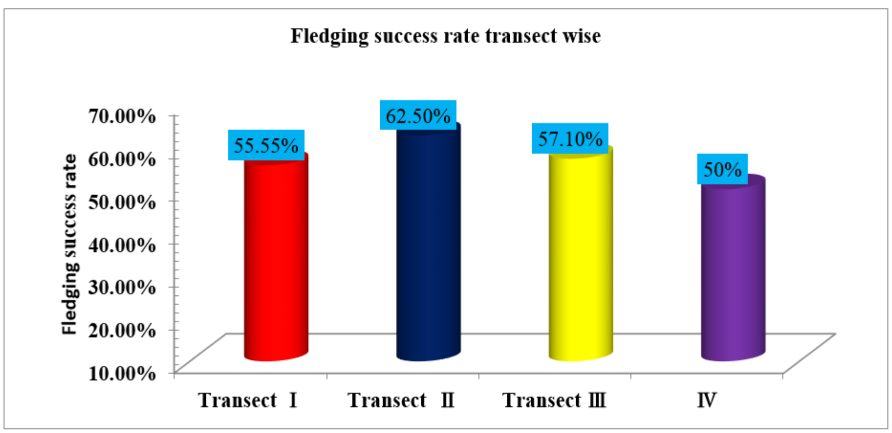

Figure 2: Fledging success rate in the selected transects of southern landscape of Kashmir Valley

Breeding Success

The overall breeding success rate in the selected transects varied significantly among the transects (table 7).Breeding success rate of 41.66% was found to be highest in transect Ⅱ and least in transect Ⅳ with a success rate of 26.66 %(Figure 3).The obvious reason for least breeding success rate in transect Ⅳ is that the factors such as predation, physical damage , embryonic deformity, interspecific and Intraspecific competitiveness in overly dense colonies were observed to be more severe and pronounced than in other transects.

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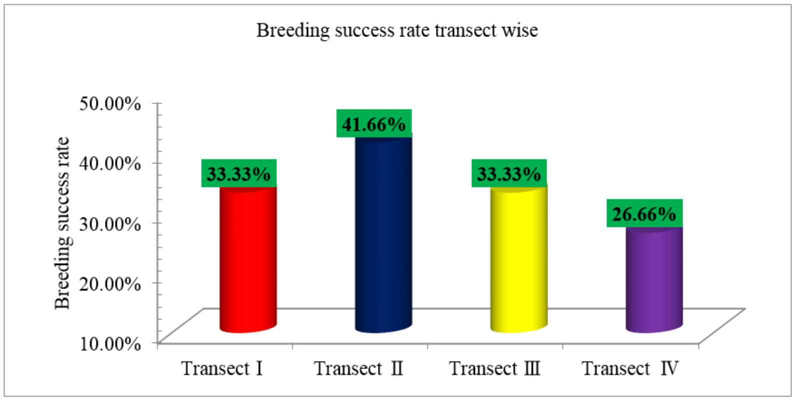

Figure 3: Breeding success rate in the selected transects of southern landscape of Kashmir Valley

Table 7: Incubation period, hatching success rate, fledging success rate and over all breeding success rate of common myna in the selected transects of Southern landscape of Kashmir valley

Study area	Transect	No .of nests observed	Sample size (No. Of eggs)	Incubation period (days)		Hatching success rate (%)	Fledging (Days)		Fledging success rate (%)	Breeding success rate (Total Success rate) (%)
				Range	Mean±S.E		Range	Mean±S.E		
Southern Landscape	Ⅰ	4	15	12-15	13.5±0.64	60%(n=9)	19-30 days	24.4±1.04	55.55%(n=5)	33.33%
	Ⅱ	4	12	11-14	12.5±0.64	66.66% (n=8)	19-27 days	23±0.91	62.5%(n=5)	41.66%
	Ⅲ	4	12	11-14	12.5±0.64	58.33% (n=7)	19-27 days	23±0.91	57.1%(n=4)	33.33%
	Ⅳ	4	15	11-13	12± 0.57	53.33% (n=8)	18-25 days	21.5±0.86	50%(n=4)	26.66%

Table 8: Multiple regression on the breeding parameters hatching success rate, Fledging success rate and overall breeding success rate

Over all breeding success rate (Dependent Variable)	Fledging success rate (Independent Variable)	Hatching success rate (Independent variable)	Statistical Analysis(Multiple Regression Model)
33.33%	55.55%	60%	*F statistics* =385.98.
41.66%	62.5%	66.66%	P-value = 0.03(p-value<0.05 (Entire regression is statistically significant).
33.33	57.1%	58.33%	p-value of individual independent variable hatching success=0.18 (p-value > 0.05) (Statistically insignificant regression)
26.66%	50%	53.33%	p-value of individual independent variable fledging success , p-value =0.15 (p-value> 0.05) ((statistically insignificant regression)

F statistics =385.98, p-value = 0.03 (table 12) (p-value < 0.05) .Entire regression is statistically significant .Collectively both the independent variables, fledging success rate

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and hatching success rate are statistically significant in the prediction of dependent variable ,total breeding success. Thus it validates the rejection of null hypothesis (H_0= μ_1=μ_2=μ_3=0) and establishes acceptance of Alternate hypothesis (H_a= μ_1=μ_2≠μ_3≠0).

For individual independent variable Hatching success rate p-value = 0.18 (p-value > 0.05) and is thus not statistically significant in the prediction of dependent variable, total breeding success.

For individual independent variable fledging success rate, p-value =0.15(p-value> 0.05) (Table 8) and is therefore not statistically significant in the prediction of dependent variable, total breeding success.

Nesting success and Nestling Mortality

In total, 18 fledglings out of 54 eggs laid in 16 nests successfully fledged out, a nesting success rate of 33.33 %(Table 7) .On an average each nesting pair resulted in successful fledging of 1.12 young ones .A total of 36 eggs and nestlings failed to either hatch successfully or failed to fledge out due to multitude of reasons .The prominent factors that were found to negatively influence hatching of eggs included hatching failure ,predation of eggs by aggressive predators like Corvus splendens ,Egg desertion ,Embryonic underdevelopment , mechanical (physical) damage to eggs such as destruction of nest laden with eggs by humans in human populous areas , rolling down of eggs from the nest .9 unhatched eggs were examined by piercing their egg shells to ascertain the exact details of unsuccessful hatching .6 out of 9 unhatched eggs were found to be infertile as there was complete absence of any embryonic evidence. Therefore it was assumed that the ultimate cause of hatching failure is largely attributed to absence of embryonic development (infertility).

Factors that caused damage to nestlings

A total of 14 hatchlings (43.75%) were lost due to varied factors. These factors were more or less prevalent in all the transects under study.

Predation

The sudden disappearance of nestlings from the nest was assumed to be case of predation. Predation accounted for 42.85% (n=6) (Table 9) loss of nestlings and was therefore found to be a dominant factor in loss of nestlings. The severity of predation was observed to be more lethal in case of open nest than cavity nest. Infact on a number of occasions the predation led to the loss of entire brood in the open nest. The intensity of predation was mild in cavity type nest. In cavity nests single young one was observed to be missing at a time. The Corvus splendens was found to be a major predator.

Intraspecific competition and starvation

Circumstantial evidences corroborated that n=5(35.72 %) (Table 9) nestlings were lost as a result of Intraspecific competition among nestlings for food and space in overly dense colonies and where the brood size was comparatively larger.The uneven hatching pattern

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resulted in the development of hatchlings of varied body weight .In larger broods few young ones continued to remain stunted and underdeveloped due to intense and fierce Intraspecific competition. Such young ones ultimately died in the nest and were assumed to be the consequence of starvation.

Anthropogenic damage

The cases of brood damage by humans were also witnessed especially where open nests were built in the close vicinity of humans. A total of n= 2 (14.28%) nestlings loss were entirely attributed to damage by humans. The children were seen playing with the helpless nestlings on rare occasions and resulted in physical damage to the nestlings. Serious injuries ultimately led to death of the nestling.

Disease

Some nestlings were observed to be infested with unknown infections and signs and symptoms were visibly marked on the body. These nestlings were unable to grow normally as compared to healthy and normal nestlings. A total of n= 01 (7.14%)(Figure 4) nestling were found to diseased and finally failed to fledge out successfully and died subsequently.

Table 9: Causes of fledgling loss in the southern landscape of Kashmir valley

Study area	No .of nests observed	No. of eggs laid	No. of young ones hatched	No. of young ones fledged successfully	No. of fledglings lost	Causes of fledgling loss	No. and percentage attributed to a particular cause
Southern Landscape	16	54	32	18	14	Predation	n=6(42.86%)
						Intraspecific competition and starvation	n=5 (35.72 %)
						Anthropogenic damage	n=2 (14.28%)
						Disease	n=1 (7.14%)

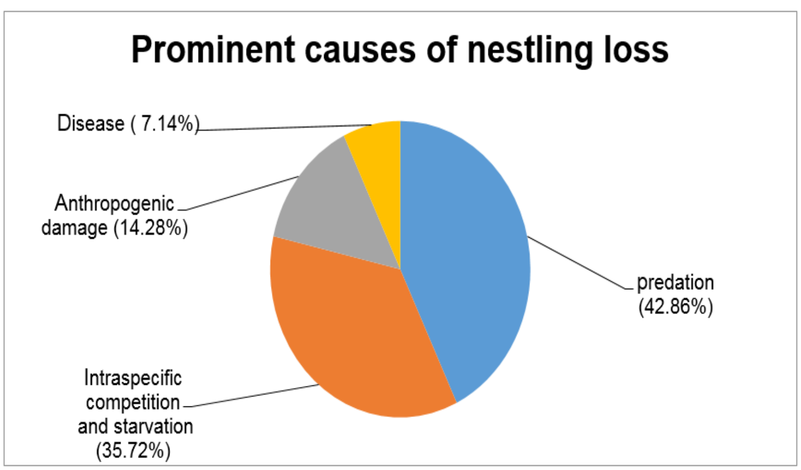

Figure 4: Prominent causes of nestling loss of common myna in southern landscape of Kashmir valley

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DISCUSSION

Liebe zeit and George (2002), Marshall and Cooper (2004) Ali and Santhanakrishan (2005) during their research on nesting ecology pointed out that selecting an appropriate nesting site is regarded as an inevitable and decisive factor for potential reproductive success in avifauna species and concluded that birds likely to prefer those nesting sites that ensure round the clock protection of their nests from extreme weather events and predators. During the study, it came to the fore that natural nest were preferred on varied sites such as trees, walls of concrete structures and hallow aeration pipes. The findings of Tyagi and Lamba (1984) are in sync with the current study and reported that in nature, a hole in a tree or a wall is the most common .The myna was found to share the nest with other locally found birds especially Passer domestics and White cheeked Bulbul. Common myna was also found to reuse nests of other birds preferably of those who had a breeding period prior to myna. Panicker (1980) observed that when barbets were done with their breeding, the nest was taken over by the Brahminy Mynas at the height of 5.18 to 7.62 meters Cavity nests were majorly preferred than the natural sites across transects under study. The preference of cavity nests over natural nesting sites seems to be well thought out strategy by common myna as cavity nesting such as building holes, hollow pipes ,tree holes mediates common myna by providing narrow range conducive climatic conditions for eggs and hatchlings and also minimize risk of predation to nests. Nilson et al (1986), Ali and Santhanakrishan (2015) during their field investigation on nesting ecology of common myna also observed the preference for cavity nesting by common myna. The height of the nest of common myna was found to vary between 3-8m in the selected transects under study. The nesting success rate was found to be prominent for those nests which were located at an elevated height in all the transects under study. The nesting site selected at an elevated height had definitely a competitive edge over a nesting site selected at a lower height in terms of safe and secure passage from the predators and the anthropogenic disturbance .Fisher and Wiebe (2005) had emphasized that selection of nesting sites by cavity nesting birds is highly influenced by the height above the ground together with the flora diversity of the area. Shoma and Begum (2020) during their research titled comparative nesting patterns and success of mynah and starling (aves: Sturnidae) inhabiting Jahangirnagar University Campus, Bangladesh came up with observations on expected results and documented that height of the nest facilitates a significant role to safeguard nests from the predators and concluded that nests situated at lower heights are prone damage by predators and human disturbances. They also observed during their research that the nests which were damaged and destroyed by human interference, were usually situated at a height of less than 5m.Similar sort of results surfaced from the field work of Jahan et al (2018) which corroborated with the current study and documented that risk of predation and human led disturbance is two times higher for the nests located at less than 5 m height. In transect Ⅲ, where tree hole nesting is predominant, the common myna used the natural cavities of tree trunks as prime nesting sites. This observation is in sync with the findings of the Shoma and Begum (2020) who during their research titled comparative nesting patterns and success

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of mynah and starling (aves: Sturnidae) inhabiting Jahangirnagar University Campus came up with observation on similar lines on nesting pattern of common myna. Their nesting observations solidified the observations current study by stating that the common myna used the natural cavity of branches of dead tree trunks and the nests earlier carved out by other cavity dwelling nesters like wood pecker and barbet . The finding of Pakkala et al (2017) also corroborating the findings of current study by stating that cavity –nesting birds inhabit previous or already existing nests and thus conserve time and energy. The nesting dimensions such as width and depth varied significantly depending upon the nesting site. Kosinski and Ksit (2007), Mumthaz and John (2017) during their research work on nesting ecology documented that shape and size of the nest chamber relies on species and the entry hole varies and is dependent on the size of birds.

During the current study clutch size of common myna in all the selected transects ranged between 3 to 4 eggs but clutch size of 3 eggs were more in sight . Sengupta (1982) reported clutch size averaged 3.72 ± 0.45 during their research work on n=25 nests of common myna. These findings are almost similar with the findings of the current study on clutch size .The observations of Lamba (1963) on clutch size of common myna differed with the findings on Clutch size of common myna in present study and documented the average clutch size 4.5 ± 0.51 SD during their investigative observations on n=20 nests. Dhanda and Dhindsa (1996a) established through their research work that the average clutch size 4.8± 0.9SD, n=22 in artificial nest boxes was significantly greater than that in natural nest sites having average clutch size 3.9± 0.8SD, n=16.

Incubation period was observed to range between 11-15 days with average 13d±0.70 d S.E .Telecky (1989) in his PhD thesis on breeding biology and mating system of common myna reported similar sort of results and established that the incubation of common myna averaged 13.02 ± 1.08 SD and this result is synchronous with the findings of the currents study. Counsilman (1974a) during his research work in New Zealand observed that the incubation period of common myna averaged 16 days which is not in conformity with the results of the current study .Sengupta (1982) during his research work on the breeding biology of common myna in India observed that the incubation period of common myna averaged 13.9 d±0.25 and is in total conformity with the findings of the current study and also reported that the variation in incubation period in selected transects is influenced by environmental circumstances like temperature and altitude which might have an impact on the incubation period.

The type of habitat had an impact on the morphometric variables of eggs of common myna. The eggs observed in the transect Ⅳ were found to be broadest with average width 17.55± 0.25mm and heaviest with average weight 7.5-8.5g. The length of eggs varied among transects .The maximum length of eggs was found in transect Ⅳ and averaged 23.49± 0.31 and minimum length was observed of eggs found in transect Ⅲ and averaged 21.98± 0.04 .The size of eggs reported by Sengupta (1982) during their research work on common myna in new Delhi , India is not in total sync with the data of current study and they have established the length of the eggs of common myna averaged 29.0mm

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±0.41 SD. Egg width was found to be smallest with average width 15.97±0.03mm and egg weight with average weight 7.4± 0.2 g was observed in case of eggs collected from transect Ⅲ.The prominent factor attributed to increased egg size dimensions in transect Ⅳ is probably higher abundance of food resources as the transect is highly urbanized transect .Dhanda and Dhindsa (1998) during their research titled Breeding Ecology of common myna Acridotheres Tristis with special reference to the effect of season and habitat on reproductive variables had made observations on expected lines and documented that habitat significantly affects breadth and volume of eggs. They observed that eggs in the poultry farm area were broadest and had greater volume and smallest egg width and volume were observed in shisham woodlot. In all the transects under study, it was observed that the clutch size of common myna ranged between 3 to 4 eggs but clutch size of 3 eggs were more in sight. The results of Shoma and Begam during their research on comparative nesting patterns and success of mynas and starlings inhabiting Jahangirnagar, university campus, Bangladesh were a bit different from the current study and reported that the clutch size of common myna ranged between 2 to 6 eggs and the findings of Jahan (2010) documented that the clutch size of common myna varied between 4-6 which again is not on expected lines with the results of current study. As per the findings of Kaur and Khera (2014) and Sethi and Kumar (2018), they documented that the clutch size of common myna ranges between 4 to 5 eggs, which is to some extent relevant with the findings of current study. Klomp (1970) , Perrins and Jones(1974) have given detailed insight on variation of clutch size and have reported that in majority of species clutch size is influenced by genetic factors like hereditary features as a consequence of selection by nature and normally is mediated by covariant like nestling development ,body size and type of nest. As per the findings of Slagsvold (1984), Clutch size plays key role in facilitating reproductive efforts and thus can impact the overall breeding success. The clutch size of first brood was observed to 3.5±0.22 (n=6), of second brood 3.5±0.28 (n=4) and of third brood was found to be 3.33±0.33 (n=3). Clutch size showed no significant difference between the successive broods. The observations of Dhanda and Dhindsa (1998) during their research titled Breeding Ecology of common myna Acridotheres Tristis with special reference to the effect of season and habitat on reproductive variables are in sync with the understanding of current study that clutch size did not differ significantly among successive broods and further elaborated that clutch size in June (3.56±0.13, n=16) did not varied significantly from the clutch size in July (3.67±0.33, n=3).

In all the transects under study, the incubation period was observed to range between 11-14 days with average ( ). The females were observed to incubate the most part of the time and were also seen to incubate the eggs all alone at night and males normally participated in incubation during the day. The newly hatched young ones were found to be underdeveloped, naked and blind (plate old home pix) and are not capable to feed or care for themselves and are unable to move of their own after hatching. . Both parents were actively seen feeding their young ones for round about 22 days or more. Both the partners were seen taking food in their beaks to feed the hatchlings .As per the findings

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of Tanya Dewy , Editor animal diversity Web , the incubation period of common myna ranges between 13-18 days and thus clearly suggests that geographical location of a place affects incubation in birds .He also reported that when the young ones are hatched they are altricial and blind and further continued that both the parents feed the young ones for nearly three weeks , during the fledging period and infact continue to do so for up to three weeks after the young ones leave the nest. He also documented that the young ones are initiated to beg when the parents give a trill while proceeding towards the nest with food.

The newly hatched young ones were found to be underdeveloped, naked and blind (plate old home pix) and are not capable to feed or care for themselves and are unable to move of their own after. It was observed that the recently hatched nestlings exhibited vigorous growth in the initial 4-6 days after hatching and then showed a gradual decline in growth rate. The newly hatched young ones roughly attained highest growth at the age of 15-16 days and there after witnessed abrupt decline till the initiation of fledging .It was quite evident from the observation of growth pattern of hatchlings that it followed a sigmoidal curve of growth pattern. Dhanda and Dhindsa (1998) during their research titled Breeding Ecology of common myna Acridotheres Tristis with special reference to the effect of season and habitat on reproductive variables too had come up with similar findings and have reported that the newly hatched young ones enormously gained weight in the first five days after hatching and then showed incremental decline in growth rate. As per their findings the young ones had peaked in terms of weight gain at the age of 15 days, thereafter the weight exhibited a degree of decline till they became viable for the flight. They also concluded that the pattern of growth of hatchlings followed a sigmoid curve.

The fledging period in the selected transects under study ranged between 18-30 days and averaged 24± 1.08.The fledging period differed significantly among the transects as the four designated transects represented four diverse habitats and were characterized by prevalence of different set of environmental factors.

Fledging period of shorter duration was observed in the transect Ⅳ and was found to range between 18-25 days averaged 21.5±0.86 .Fledging period of longer duration was observed in transect Ⅰ and was found to range between 19-30 days averaged 24.4±1.04 . Telecky (1989) during his research work established that the nestlings fledged 23.8 d± 2.4 SD after successful hatching. These results are on expected lines with the outcome of current study. Counsilman (1974a) during his research on Indian myna in New Zealand reported that the fledging of common myna varied between 20-30 d, averaged 27 d. Sengupta (1982) during his research on reproductive behaviour of common myna established that the fledging period of common myna ranged between 22 and 24 days and is therefore in sync with the results of the current study

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