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A CONTRIBUTION TO THE BREEDING
BIOLOGY OF TWO INDIAN MYNAS

by

A. K. TYAGI AND B. S. LAMBA

Issued by the Director
Zoological Survey of India, Calcutta

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1984

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INTRODUCTION

Mynas, along with crows, sparrows and parrots are the most common birds that haunt the abode of man. The mynas have been very closely associated with man from time immemorial. They are well known in Indian folk lore as good singers, talkers (imitators of the human voice) and legendary story tellers (of Kissa-e-Tota Myna). They are considered to be good friends of farmers as they are supposed to feed upon insects harmful to agriculture. Mynas enjoy a very wide distribution in India.

In spite of their abundance and proximity to human society, deplorably little is known about the breeding habits of mynas.

Our present day knowledge of breeding biology of the Indian Pied Myna, *Sturnus contra contra* Linnaeus and the Brahminy Myna, *Sturnus pagodarum* (Gmelin), remains restricted mainly to the topics dealt with by Jerdon (1862-64) who treated at length the breeding season, nesting sites, description of eggs and the defence of their nests and young.

Sporadic brief notes on the topics dealt with by Jerdon (1862-1864) kept on appearing in the various scientific journals dealing with Indian ornithology till Hume (1873) collated the then existing published data along with other extensive data communicated to him by his correspondents. Hume's (1873) collation covered all the topics touched upon by Jerdon (1862-64) but in much greater detail. He included the accounts of many other workers giving details of their observations or findings on nests and eggs. Hume's revised edition (1889-90) contained, in addition to his own observations of various topics listed above, similar verbatim accounts of a large number of workers from various parts of the country, either published elsewhere or communicated to him directly. The only ornithologist who ventured out of the beaten track was perhaps C. M. Inglis (1910) who gave an account of feeding of the young of the Pied Myna. E. H. N. Gill (1923) described the nest and eggs of the species in his account of common birds of United Provinces.

Cripps 1873, Ried 1881, 1887, Barnes 1890, Inglis 1901, Osmaston 1913, Whistler, 1919, Field 1922 and E. H. N. Gill 1923 also contributed to one or the other aspects of the breeding biology of these species.

Fourty years after Hume's collation, Baker (1932-35) compiled accounts of nidification of various subspecies (including the species under study) without substantially enriching the information supplied by Hume. Not much seems to have appeared in the press since then.

In the recent past J. Ara (1954) observed the copulation of the Pied Myna. Narang, Tyagi and Lamba (1978) have given a brief description of the ecology of Indian Pied Myna ; and Lamba and Tyagi (1977) have described the incubation period in Brahminy Myna.

Studies on the breeding biology of these species were undertaken during a five year period, from 1975-1979, at Dehra Dun where the authors were then posted.

MATERIAL AND METHODS

Most of the observations for this study were made in nature through a pair of 6×30 prismatic field binoculars. Observations were started very early in the breeding season before the flocks disintegrated into pairs.

About a dozen nest boxes (wooden) measuring 15×15×22 cm with the entrance hole of 4 cm and 6 cm were also placed in the trees in the compound of a large bungalow at 13 Subhash Road, Dehra Dun to lure the Brahminy Myna which is a tree-hole breeding species.

Before and during the nest building stage the sexes, wherever necessary, were determined by actual examination of the gonade after shooting the bird. After the construction of the nest one (and in some cases both) of the occupants were captured with mist nets and ringed with coloured plastic rings for visual recognition.

The process of nest construction was watched from a distance from behind a stout tree, bush or from within a parked vehicle. The material used for nest construction and dimensions of the nest were observed and recorded from half a dozen or so nests brought to the laboratory for the purpose.

Soon after the start of nest construction regular daily observations were made by climbing up to the nest. Occasionally light bamboo ladders (6 to 8 metres) were used for the purpose. Nests situated in very thin branches were observed with the help of small boy climbers who would communicate/or lower the contents of the nest in a small tin container for taking notes, measurements, weights etc. The contents were, of course, replaced intact after the needful was done. As far as possible efforts were made to visit the nests under observation daily during fixed hours in the morning (forenoon) and evening.

During the laying and hatching periods a number of selected nests were observed daily between 05.30-07.30 hours, 09.30-12.30 hours and 16.30 to 18.30 hours. For certain specific observations additional but irregular visits were made at night, dawn and dusk.

Eggs for incubational studies were marked/dated with indelible Indian ink. For recording description and measurements, eggs from certain deserted nests and nests difficult to approach for regular observations were brought to the laboratory. A pair of vernier callipers was used to take their measurements in millimeters. An electronic single pan balance true to .001 g. was used to record the weight of eggs. The colour of the shell was deciphered by comparison with 'Mathuen hand book of colour'. Successive eggs of a selected number of clutches were measured and weighed in the field itself.

In a few selected nests the freshly hatched nestlings were banded with coloured plastic bands (for individual recognition) for studying growth rate and behaviour patterns. A single pan electronic balance was used for taking weights of the nestlings. Grown up nestlings were put in cloth bags before weighing. The weight of the bag (and droppings, if any) was deducted from the weight thus recorded.

For certain specific studies like growth of feathers etc. some nestlings were brought to the laboratory. Such nestlings were sacrificed to determine the type of food on which they were being fed.

All the nest life studies were made visually by climbing up to the nest or through a pair of 6×30 prismatic binoculars from a safe distance.

The photographs of nests, eggs, nestlings etc. were taken with an Ashai Pentax Camera with a normal 50 mm/F 1.2 lens and a 500 m/F 8 lens.

The map of the study area was obtained from the Survey of India, Dehra Dun, and data on the weather conditions from the Forest Research Institute and Colleges, Dehra Dun.

HABITS AND HABITATS

Both the species of mynas were studied in nature. Either one or the other species of mynas is found throughout the country wherever man dwells.

The Indian Pied Myna, is one of the commonest species of birds in northern and eastern India. Local and patchy in distribution, it is found up to c. 700 m. in the foot hills.

This species is a sociable, predominantly insectivorous, and ground feeding. It is found in noisy squabbling flocks during non-breeding season, commonly in association with other mynas, near villages and human habitations. Its favourite feeding grounds are damp grazing

grounds, banks of ponds and tanks, sewage farms, municipal refuse dumps, flooded fields and riverine belt.

On spotting an enemy, an alarm call is given out by the discovering individual. The alarm call is taken up by other members of the community within hearing distance and relayed, thereby spreading it to a much greater area from which all individuals rush, leaving all other occupations, to the scenes of excitement may it be a snake, an ornithologist interfering with nests/young or a fallen nestling. Soon the locality teams with agitated and calling mynas.

The Brahminy Myna is widely distributed in India from southern Kashmir to Kanyakumari up to 88°E longitude in the east and Rajasthan, northern Gujrat and Kutch in the west. Locally common but capricious.

The species is sociable, often found in family parties of 4 to 7 and sometimes including in communal roosting. It lives commonly in association with other mynas and other frugivorous and nectar-eating birds. It feeds along with the Pied, Jungle and Common Mynas on grazing lands, marshy grass lands and moist tank margins. The fruit of Lantana, a common shrub of the Doon valley, is the most favourite fruit of this species.

One thing that is indisputably common to all these species of mynas is the fact that wherever they are found they breed. The suburbs of Dehra Dun, where the present study was undertaken, were found to be naturally rich in having as many as five species of mynas. As the breeding biology of Common Myna has already been studied by Lamba (1963) and Sengupta (1965 and 1968) in detail, this species was not taken up for detailed study. The Bank Myna and the Jungle Myna are not as common as the other three and not enough nests could be located for a thorough study. Only two species Pied Myna *Sturnus contra contra* Linnaeus and the Brahminy Myna *Sturnus pagodarum* (Gmelin) were taken up for detailed studies.

STUDY AREA

Physiography

Studies on the breeding behaviour of the mynas were carried out during 1975 to 1979 in the Doon valley in the city of Dehra Dun and surrounding areas, mainly at Ballupur forest, Krishna Nagar, Prem Nagar forest, Raipur Road, Sahastradhara Road and Lachhiwala (Fig. 1).

The Doon valley which covers an area of about 1200 sq. km. lying between longitudes 77°35' E and 78°2' E and latitudes 29°57' N and 31°2' N is situated in the northern part of Uttar Pradesh.

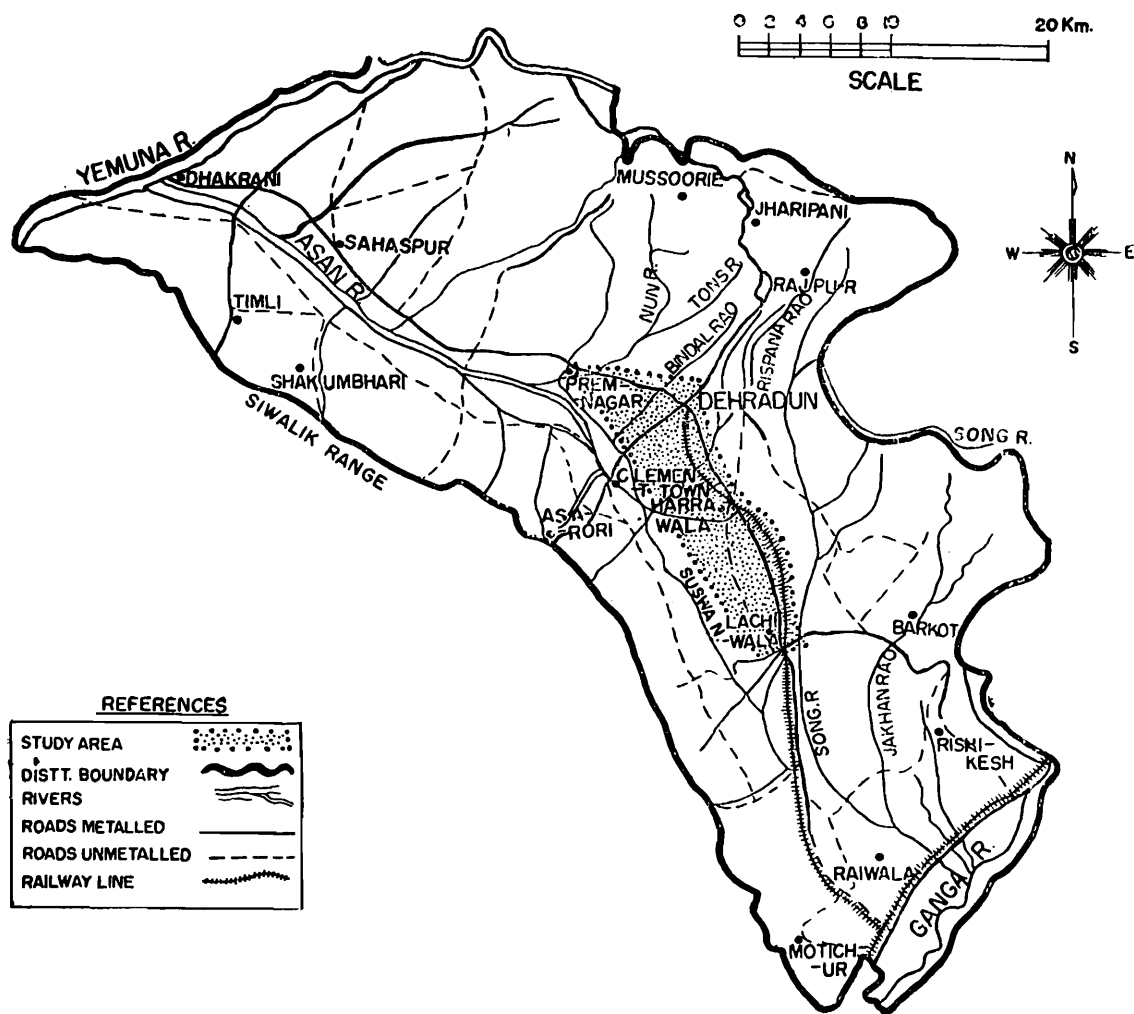


Fig. 1. Study area

The valley is enclosed by the Himalayan ranges in the north, Siwalik hills in the south and by rivers Ganga and Jamuna in east and west respectively. The altitude of the outer ranges of the Siwalik hills in the south and Himalayan ranges in the north is about 1000 m. The ranges meet midway at an altitude of about 640 m. The valley gradually slopes with a gradient of 6 m per km. on eastern side towards Ganga and on western side towards Jamuna. The fall is about 300 m. on both the sides.

The valley is very rich in vegetation. The Himalayan foot hills are covered with profuse Sal forest whereas the Siwaliks are covered with a luxuriant deciduous forest. More than 33 species of trees, 125 species of shrubs, herbs and climbers have been reported from the valley. Among the larger trees made use of by the mynas for nesting etc. are Sheesham (*Desbergia sissoo*), Siris (*Acacia sarrisa*), Eucalyptus (*Eucalyptus*

globulus citriodora), Peepal (*Ficus religiosa*), Banyan (*Ficus bengalensis*), Neem (*Aradiracta indica*), Amaltas (*Cassia fistula*), Mango (*Mangifera indica*), Jamun (*Eugania jambolghna*), Lichi (*Litchi chinensis*), Guava (*Psidium guajava*), Plum (*Prunus domestica*), Peers (*Pyrus communis*), Fig (*Ficus carica*) and Champa (*Magnolia champaka*).

The city of Dehra Dun lies at an altitude of 650 m. in the middle of Doon valley, roughly at 78°2' E east and 30°20' N. It is mainly a residential city, and like all old cities, is not well planned and is overcrowded. Dalanwala area in the city and the Cantonment areas of New Cantt and Clement Town are better planned and have a large number of trees and gardens attached to residential houses. In addition to being renowned for Indian Military Academy, Forest Research Institute and Colleges, Ordnance Factory, Survey of India and Oil and Natural Gas Commission, Dehra Dun city is a base market for Garhwal hills.

The river Rispana on east and river Tons and Bindal on west are the biggest seasonal rivers which enclose the Dehra Dun city and adjoining areas on both sides. These rivers are drained by small streams which carry the drainage of the city into these rivers. This river system supplies much moisture to the soil, which is essential for the growth of vegetation including trees in which most of the birds (including the mynas) roost, build their nests and feed upon. In addition, most of the better types of houses in the suburbs and cantonments have small attached gardens with a number of large trees used by the mynas. There are also many big horticultural gardens which attract the mynas in large numbers. One big garden of mango, guava etc of about 2 hectares at Ballupur Road, was converted into residential colonies in 1979. Dirty drainage nullaha flows on two sides of this garden making it an ideal place for mynas to roost and breed. Another big mango and guava garden which attracts a large number of mynas is located on Raipur Road.

Climatic factors

Dehra Dun has mild summers and slightly severe winters. The climate of Dehra Dun differs substantially from that of the plains of Northern India. The temperature is slightly lower than in the plains because of the valley's elevation and its surrounding. The Siwalik ranges partly block off and cool the hot winds that blow during the hot weather in the north Indian plains in summer. Being located in the valley, it is protected by the Mussoorie hills from cold Himalayan winds during winter.

Seasons

The year at Dehra Dun may be divided climatically into three main seasons, the cold season (from November to March), the hot season (from April to the middle of June) and the rainy season (from later half of June to first half of October).

The cold season starts in earnest in November when the average minimum temperature drops to about 8°C and extends to March when the average minimum is 8.5°C. December and January, being the coldest months with the mercury dropping to an average of as low as, 2.7°C at times.

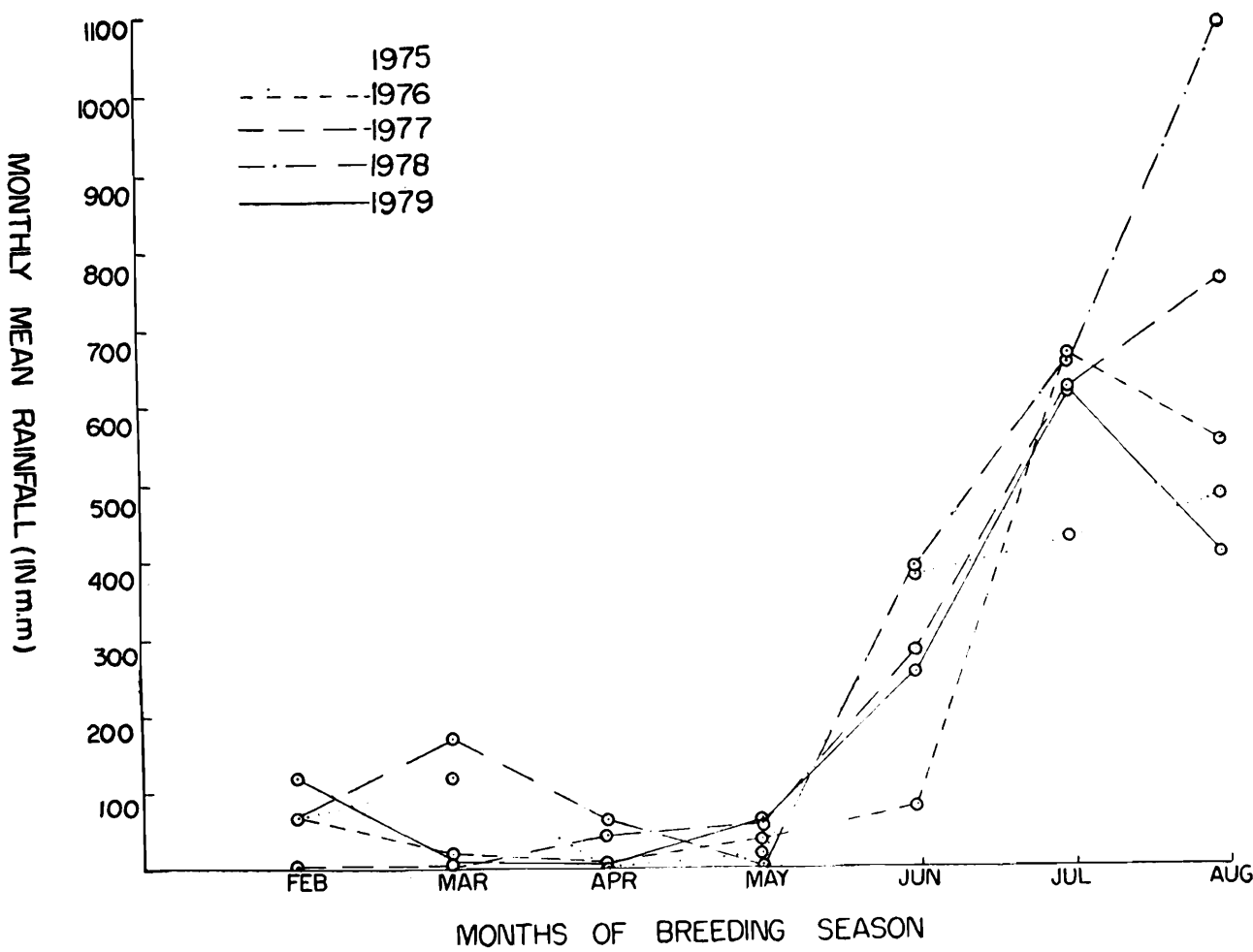


Fig. 2

The hot season begins from April when the average maximum temperature shoots up to 31.9°C. The rise of temperature continues reaching its maximum in mid June when the average maximum temperature rises to 36°C. Thus May and June are the hottest months in Dehra Dun. This period is generally dry except for the scanty premonsoon thunder showers.

The rainy season or the monsoon season begins from mid-June.

The south west Monsoon winds blow from the Bay of Bengal and result in the rains for about four months. As a result, the temperature falls slightly and the humidity increases steeply to about 90%.

The breeding season of the mynas starts slightly before the hot season and extends well into the rainy season.

Rainfall

The south-west monsoon is the chief source of rains in Dehra Dun though some rainfall usually occurs almost throughout the year. The monsoon breaks over Dehra Dun by the latter half of June, is at its heaviest during July and August and gradually tapers off in September. August has the maximum rainfall sometimes as much as 1094.6 mm. November is a month of 'no rains'. In winter also (from December to February) an average of 41 mm. of rainfall occurs in Dehra Dun.

Monthly mean rainfall during the breeding season for the years of study (1975 to 1979) is given in Table 1, Fig. 2.

TABLE 1. *Monthly mean rainfall (in mm) during the breeding season for the years 1975-1979.*

Year	months						
	Feb.	Mar.	April	May	June	July	August
1975	67.1	119.2	0.0	21.4	380.1	430.8	487.7
1976	72.2	21.5	10.1	39.0	129.2	669.7	556.2
1977	1.2	6.2	39.4	65.9	285.9	627.2	767.1
1978	67.6	171.4	65.8	4.0	390.0	656.6	1094.6
1979	121.3	11.9	7.3	65.1	253.8	622.3	408.7

Humidity

The city of Dehra Dun receives good rainfall which results in the increase of relative humidity which is considerable throughout the year reaching its maximum during summer and winter rains. During summer rains it reaches a maximum of about 95%. April and May are the driest months.

The monthly mean relative humidity during the breeding season for the years 1975-1979 is given in Table 2 and 3, Fig. 3.

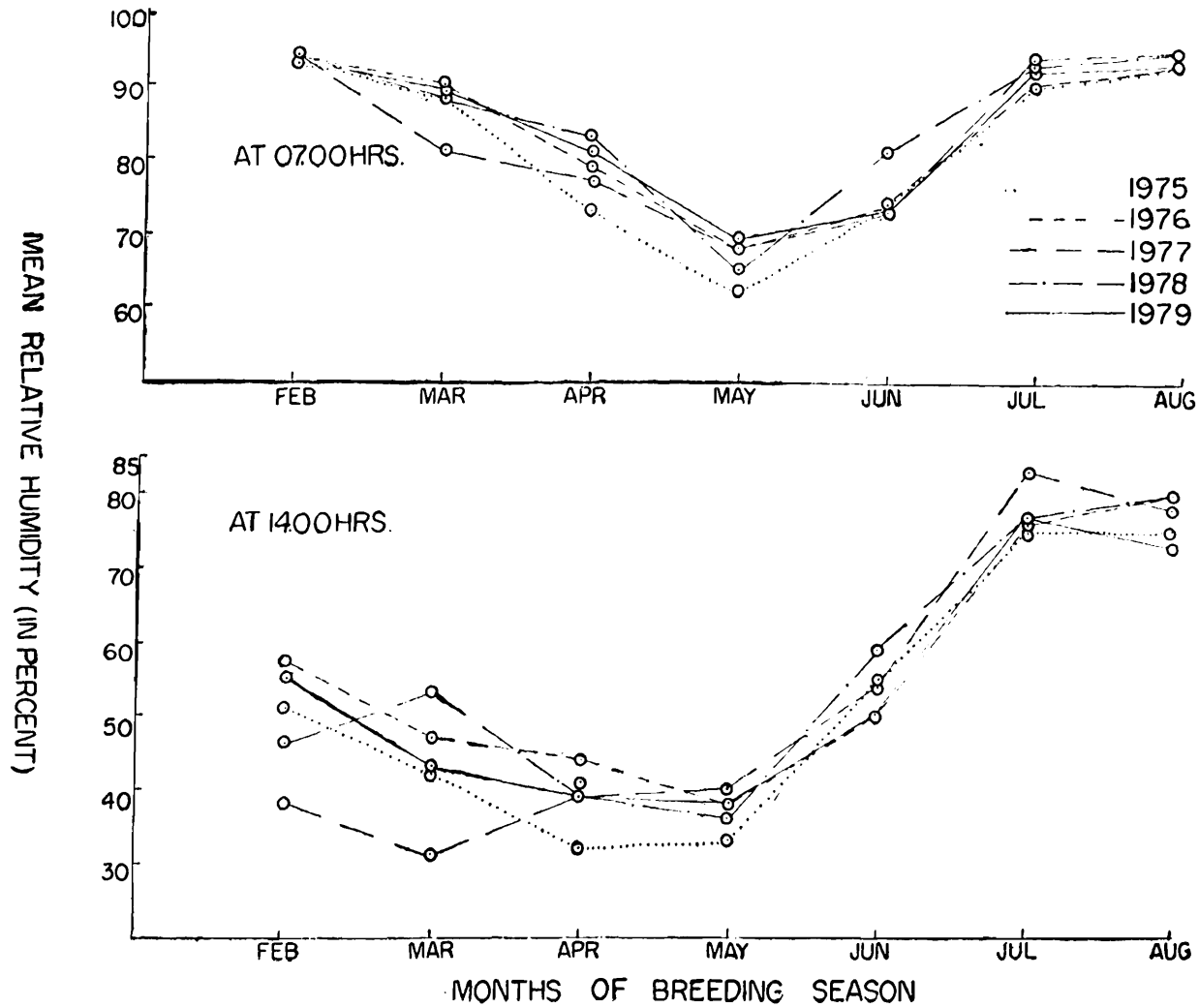


Fig. 3

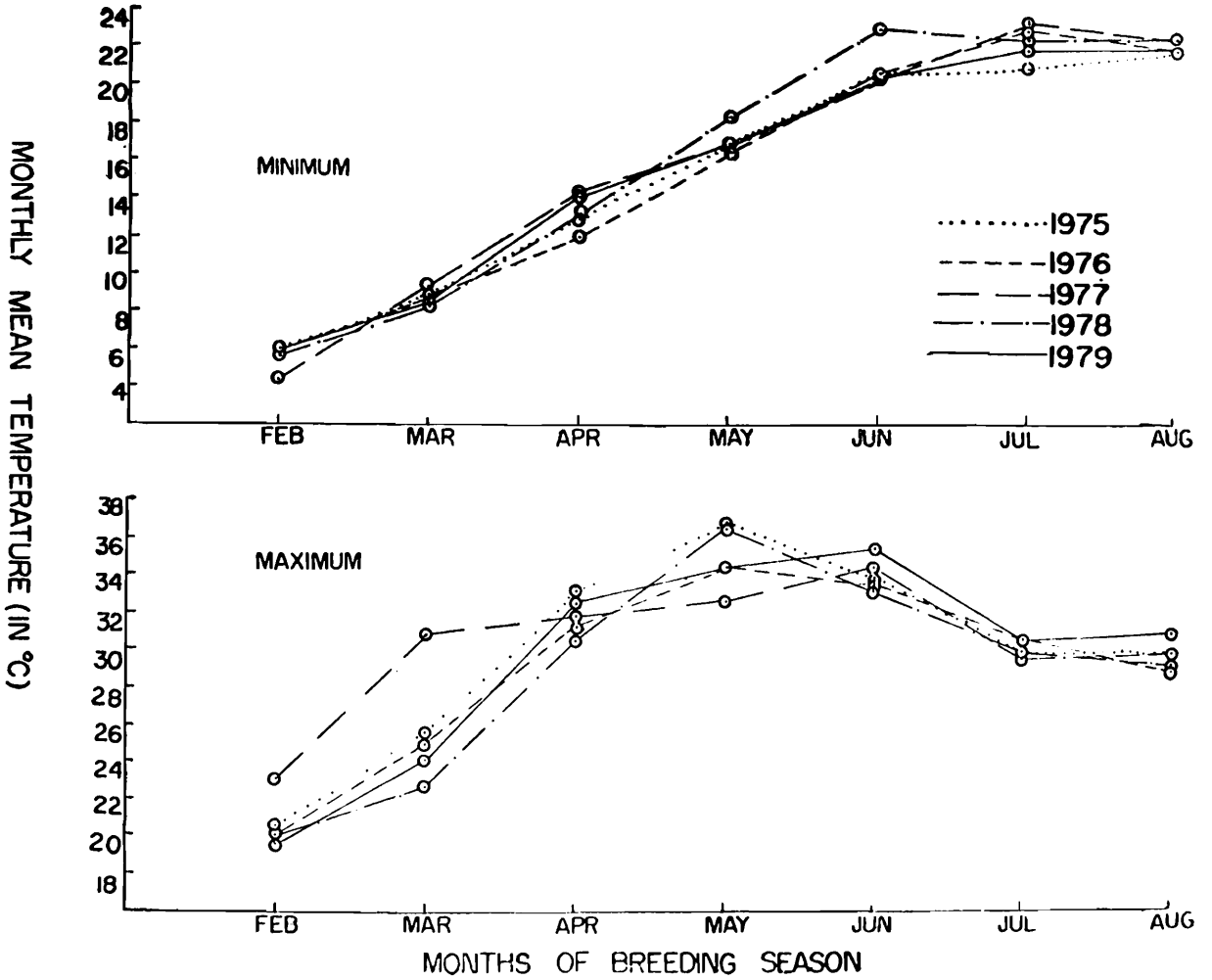


Fig. 4

TABLE 2. *Monthly mean relative humidity (in percent) during the period of study for the years 1975-1979 at 07.00 hours*

Year	Months						
	Feb.	Mar.	April	May	June	July	August
1975	93	88	73	62	74	90	93
1976	94	90	79	68	74	90	95
1977	94	81	77	68	73	94	95
1978	94	88	83	65	81	93	95
1979	93	89	81	69	73	92	93

TABLE 3. *Monthly mean relative humidity (in percent) during the period of study for the years 1975-1979 at 14.00 hours*

Year	Months						
	Feb.	Mar.	April	May	June	July	August
1975	51	42	31	33	55	75	75
1976	57	47	44	38	50	76	80
1977	38	31	39	40	54	83	78
1978	46	53	39	36	59	77	80
1979	55	43	41	38	50	77	73

Temperature

During the breeding season the monthly mean of daily minimum temperature ranges from 4.4°C in February to 23.4°C in July, while the mean of daily maximum ranges from 19.6°C in February to 36.9°C in May. The monthly mean temperature is at its lowest in February. It rises steadily thereafter until the maximum is reached in May.

The daily range of temperature is least during the months of July and August (about 6-8°C) while in February it is generally large (about 9-22°C).

The monthly mean minimum and maximum temperatures during the breeding season for the years 1975-1979 (study period) are detailed in Tables 4 and 5, Fig. 4.

TABLE 4. *Monthly mean minimum temperature (in °C) during the breeding season for the years 1975-1979*

Year	Months						
	Feb.	Mar.	April	May	June	July	August
1975	6.0	9.3	13.3	17.0	20.8	21.7	22.0
1976	6.2	8.8	12.5	16.5	20.8	23.3	22.1
1977	4.4	9.4	14.4	17.0	20.5	23.4	22.6
1978	5.7	8.3	13.2	18.4	23.2	22.7	22.7
1979	6.0	8.5	14.2	15.8	20.6	22.0	22.0

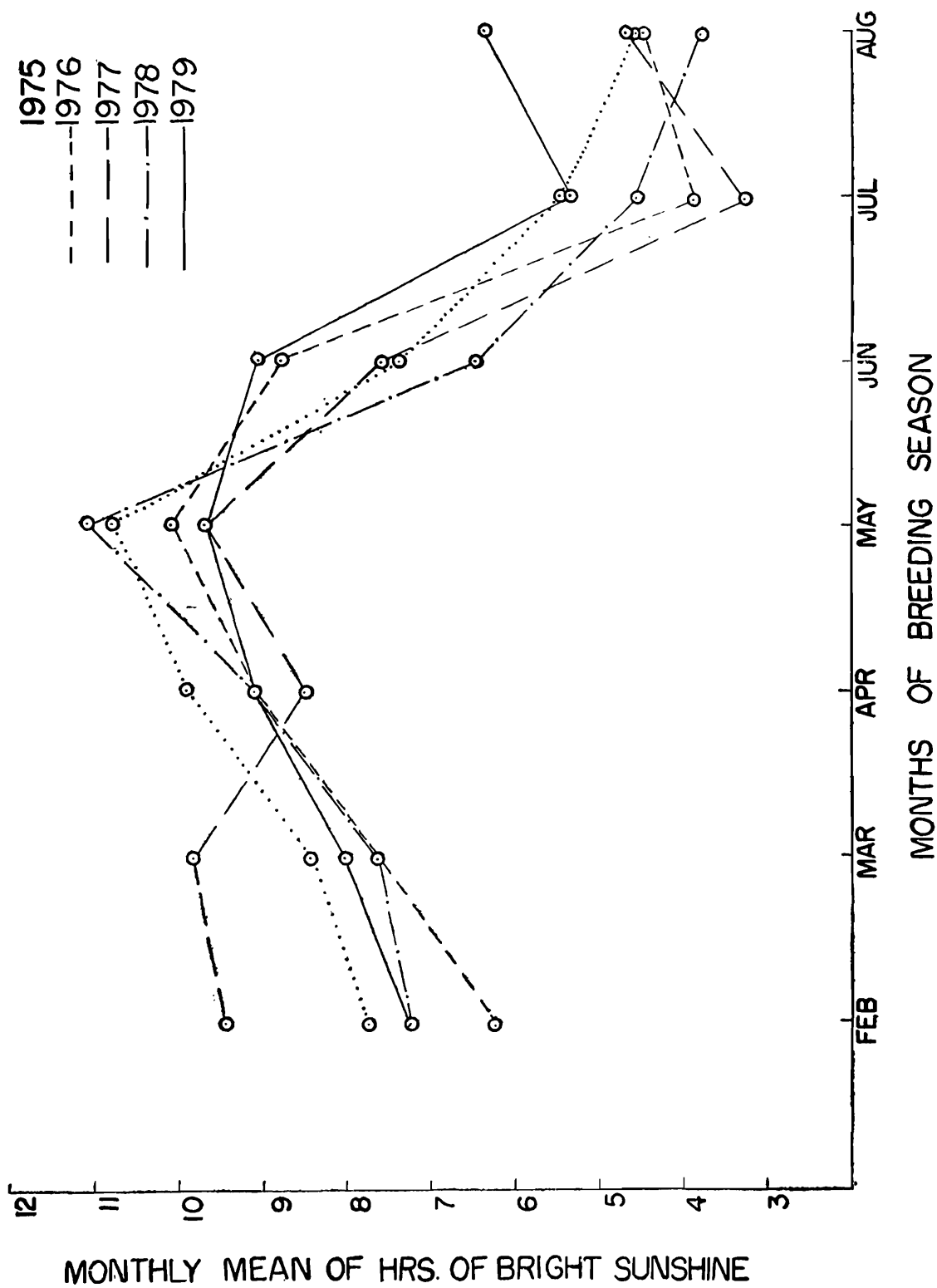


Fig. 5

TABLE 5. *Monthly mean maximum temperature (in °C) during the breeding season for the years 1975-1979*

Year	Months						
	Feb.	Mar.	April	May	June	July	August
1975	20.6	25.7	33.3	36.9	33.9	30.0	29.8
1976	20.1	25.0	31.4	34.5	33.6	30.7	28.9
1977	23.2	30.9	31.9	32.7	34.5	29.6	29.8
1978	20.0	22.7	30.6	36.6	33.3	30.0	29.2
1979	19.6	24.1	32.6	34.5	35.5	30.6	30.9

Period of sunshine

The monthly mean of hours of bright sunshine during the breeding season ranges from 3.9 hours to 11.1 hours. July being the monsoon month has the lowest hours of bright sunshine as shown in Table 6, Fig. 5.

TABLE 6. *Monthly mean of hours of bright sunshine per day*

Year	Months						
	Feb.	Mar.	April	May	June	July	August
1975	7.7	8.4	9.9	10.8	7.4	5.5	4.6
1976	6.2	7.6	9.1	10.1	8.8	3.9	4.5
1977	9.4	9.8	8.5	9.7	7.6	3.3	4.7
1978	7.2	7.6	9.1	11.1	6.5	4.6	3.8
1979	7.2	8.0	9.5	9.7	9.1	5.4	6.4

OBSERVATIONS ON THE BREEDING BEHAVIOUR

The Indian Pied Myna

Sturnus contra contra Linnaeus

BREEDING SEASON

Number of seasons and duration :

The Indian Pied Myna does not breed round the year. At Dehra Dun it was observed to have a single breeding season of about six months from late February to the end of August. In the years of prolonged winter rains the commencement of the breeding season may be delayed up to March or even April. In the year 1975 when rainfall in the second half of February was normal the breeding activity i. e. pair formation etc. started normally i. e. by the end of February. But on

account of sudden augmentation of winter rains in March (119.2 mm) further progress in breeding activity i. e. nest construction etc. was arrested till the rains slowed down by the end of March. In 1976, on the other hand, the rainfall in the latter half of February was more. As a result the breeding activity i. e. pair formation etc. did not start till the end of March. The trend of winter rains reversed in 1977. When only 1.2 mm and 6.2 mm rainfall was recorded in February and March respectively. Consequently the breeding activity in 1977 started by the end of February. In 1978 the winter rains (February 67.6 mm, March 171.4 mm, April 65.8 mm) extended well into April. That year the breeding was also considerably delayed being noticeable only by the end of April. In 1979 when the rainfall was abnormally high in February (121.3 mm.) the breeding activity started in March. The breeding activity however, lasted till the end of August during the years 1975 and 1979. Apparently the rainfall does interfere with the breeding activity. In the years 1977 and 1978 when the rainfall in July was more than normal, the eggs were not laid for the second brood although some nest-repairing activity was noticed.

The maximum number of nests under construction was observed from March end to early May. Most nests with eggs were met with during May and most nests with fledglings were noticed during May to early June. Some of the early breeders go in for a second brood also. The largest number of second clutches was found during the latter half of June to first half of July. The nestling from these second broods left the nests by the end of August.

MATING

Pair formation :

With the commencement of breeding season large flocks of Pied Myna, usually seen feeding and roosting in winter, start thinning out. The partners are sought out and courted. The factor/factors involved in the selection of a partner could not be ascertained beyond doubt. Individual compatibility perhaps coupled with the amount of attraction of the territory held by the courting male seems to play a dominant role in pair formation. Pairs once formed remained together for the total duration of the breeding season. In cases where one of the partners was shot or died during the period when the nest was under construction another partner was acquired in three out of four cases. In one case where a male was eliminated after the 1st brood had been successfully raised another male took over the territory (nest) and the female successfully mated with the new owner. A second brood was

raised in the same nest by the female. In another case where the female was eliminated after the 1st brood the male deserted the nest and left the area.

Courtship behaviour :

Courting consists mainly of feeding together and a conspicuous courtship display. During courtship display the male puffs up its feathers and bobs its head up and down a couple of times (Plate IV, Fig. 21). The courtship display of the male may or may not evoke a response from the female. The courtship response of the female almost always ends up in copulation. The female, if receptive, crouches down low spreading one of its wings fully, the head held at an angle, and the wing tip almost touching the ground, the feathers of the crown are slightly raised and the tail fanned out a bit.

Copulation :

As already stated the courtship response of the female almost always ends up in copulation. Copulation takes place either on the ground or in the branches of trees in the normal bird fashion during the courting and nest building stages. The male may or may not give out calls while mounting. The frequency of copulation is highest, four times in six hours in one instance, when the egg chamber is being constructed and the clutch is being laid. It ceases completely after the female starts incubating during daytime. The second peak of copulating activity is reached when the nest is being repaired and reshaped for raising the second brood after the departure of the first brood. The partners normally resume the same activity (feeding, nest construction or resting etc.), after the sexual intercourse.

Number of mates :

The Pied Myna is observed to be strictly monogamous : only one female is courted by a single male. After the pair formation no advances are made by either sex to other individuals of the opposite sex (mated or unmated) of the community. During the short duration of their bond they behave like true partners always living together.

Duration of Bond

The duration of the pair bond in Indian Pied Myna is apparently for four to six months in a year i.e. for a single breeding season. The pairs which emerge out of the flocks, return to the flocks after the end of breeding season. Both the males and females of two pairs which were banded for the study of the duration of bond in 1978 paired up with different birds in 1979.

TERRITORY

Definition

The birds during the breeding season resent intrusion by others of same sex and species in particular, and other species of birds and animals in general, inside a limited area around or adjacent to their nests or proposed nesting sites. This area has been termed as 'territory' and is differently described by different workers. In the following pages, however, the term territory has been taken to mean a limited area round or adjacent to the nest, or proposed nesting site, any intrusion of which by others of the same sex and same species in particular and other animals in general is resented by the owners of the nest.

As already stated the male occupies his territory early in the breeding season. The territory seems to be announced by mere presence as no distinctive song was heard. The territory is defended by the owner (unmated male) against all males of the species. All females are welcome till the pair formation takes place. After the pair formation the territory is defended by both the partners against all others of the species. But only the attempts at construction of nest by others very near to the nest or nesting tree are resented and resisted. A straggler or an occasional visitor may not be pounced upon. Occasionally, if the tree is very large with spreading branches, another pair or two may be permitted to build nests in the same tree. The occurrence of two or three nests in a single tree has also been recorded by Baker (1926).

Size

The size of the territory in Pied Myna was found to vary considerably. As already stated two or more nests may be located in a single large tree at a distance of 10-12 metres. When placed in separate or adjacent trees the distance between the nests may extend from 20 to 300 metres. This distance (or territory), of course depends on the availability of nesting trees. In a mixed Mango and Guava garden in the study area, where as many as 14 nests were located, the distance between the nests was measured with a measuring tape. It varied from 14 to 100 metres.

Defence

The Indian Pied Myna defends its territory by threat display and actual combat. The threat display consists of puffing up of the body feathers raising of the heckles and emitting loud calls with beak open and the neck extended. Normally the threat display is sufficient to

frighten intruders into retreat. If this fails an attack is launched by running to or flying upto the intruder. The beak is used as an weapon of offence. A number of sparring bouts may occur. The weaker of the two may lie flat on his/her back and try to use the claws also for defence.

When threatened by a common enemy like a raptor or a snake, some sort of community defence comes into play. In such an event some or all of the neighbouring pairs and even visitors may join hands to get rid of the evil one, in response to loud calls of danger given out by the birds first to spot the danger. This perhaps is an extension of the social defence system that the species follows in the non-breeding or breeding season. When faced with a large raptor who refuses to be frightened by the threats or ineffective attacks, the birds after a number of attempts, calm down and occupy the neighbouring trees only to launch another attack as soon as the raptor leaves its perch.

Harmless birds like House Sparrows etc. are well tolerated and permitted to perch within a few inches of the nest (Plate III, fig. 20).

NEST CONSTRUCTION

Selection of site

Apparently the male selects a site when he selects the territory. The female, after the pair formation may or may not approve the site selected by the male. In such a case nesting site is selected by the pair by mutual consent. Early in the breeding season it is a common sight to see a bird with a thin twig in beak moving from one tree to another, hesistant to place it down in a fork, or picking it up and moving away after having placed it in a thin outer fork in a tree. This bird is normally closely followed by another not carrying a stick. Obviously the nesting site is chosen with great care presumably with the safety of the nest. The site selected may often be given up in preference to a better or safer (from the point of view of birds) one. This may happen even after the start of nest construction. Which of the sexes has the final say in the matter of nest site selection is rather difficult to say. On a number of occasions such leaders (with stick in beak) were shot and examined for sex. On five occasions it turned out to be a female and on two, a male. It may be mentioned here that none out of the 12 nest boxes fixed on trees at height varying from 5 to 15 metres with 6 cm entrance hole were selected by these birds to construct their nest in.

Situation and location of nest.

Generally thin vertical forks in largish trees like, Mango, Banyan, Peepal, Kathal, Guava, Sheesham etc. about 5-15 metres above the ground, are preferred. Occasionally cross-bars on telephone, telegraph and electric poles (Plate VI, fig. 25) may be used for the purpose, especially in areas where largish trees are scarce.

The birds may take their own time in making the final selection of the nesting site. As many as 10 to 15 days may elapse after the pair formation before the actual construction of the nest is undertaken.

Nesting materials

Thin and pliable twigs, stems of small plants, grass stems, stem of creepers and twiners, strings, rags, pieces of papers, discarded cellophane wrapper, polythene bags and similar sundry materials are collected for the construction of the outer dome (Plate II, fig. 18). These materials are haunted for from under the trees, hedges, waste land, garbage dumps and cans etc. from the territory and adjoining human habitat.

The inside of the dome or the egg chamber is lined with similar but softer materials (Plate VI, fig. 26). Occasionally animals/horse/human hair may also be used along with the above mentioned materials for the lining of the egg chamber (Plate III, fig. 19).

Mode of construction and share of sexes

Both sexes gather materials for and take part in the construction of the nest. The female puts in more effort than the male who generally helps in the collection of the material leaving most of the construction work to the female. As a result the female always keeps to the vicinity of the nest when not working on the nest. Her material hunting trips also do not take her very far from the nest. When the nest is well under way the female's material hunting trips are greatly reduced. She keeps on working in the nest while the male keeps her supplied with requisite materials. Once the nest construction starts, the nest is never left unguarded. One or the other of owners is always at hand to defend and protect it from intruders and pairs of the adjoining territories who are not beyond pinching the nesting materials from deserted or unguarded nests (Plate I, fig. 16).

The maximum nest construction activity was observed between 06.00 to 08.00 hours. It slows down considerably during the day. Towards the evening there is another spurt of nest building activity reaching a second peak during 16.00 to 18.00 hours. In the nests started late in the breeding season the frequency of material hunting trips and speed

of construction is much more than those started earlier in the season. In some of these cases the material hunting and nest construction may continue throughout the day with short periods of rest, feeding or preening (Plate IV, fig. 22).

During a spell of normal construction activity as many as 38 material hunting trips an hour in the morning and 21 in the evening by both birds, were clocked.

On the approach of a raptor or in the event of a threat to the nest including an observational visit from an ornithologist, the bird outside the nest, usually the male, gives out an alarm call which makes the bird working inside, usually the females, leave the nest and take refuge in the branches nearby.

Time required for the completion of the nest

Normally it takes about 11 to 22 days for a pair to complete the nest (Table 7). The birds that start building early in the breeding season usually take longer than the once that start late. In two cases when the construction was started as late as the beginning of June, it took the birds 7 days in one and 8 days in the other case to finish the nest.

TABLE 7. *Time required for the completion of the nest*

Nest No.	Construction started on	Completed on	Time in days
1975			
1	16.4.75	8.5.75	22
2	22.4.75	14.5.75	22
6	17.4.75	9.5.75	22
9/A	20.4.75	8.5.75	18
12	9.4.75	30.4.75	21
13	24.4.75	13.5.75	19
15	28.4.75	13.5.75	15
16	8.5.75	19.5.75	11
17	12.4.75	3.5.75	21
1976			
2	26.4.76	18.5.76	22
3	18.4.76	6.5.76	18
4	20.4.76	6.5.76	16
5	30.4.76	19.5.76	20
7	1.5.76	19.5.76	18
8	3.5.76	21.5.76	18
9	3.5.76	23.5.76	20
10	4.5.76	15.5.76	11
12	13.5.76	26.5.76	13
13	28.5.76	9.6.76	12

Nest No.	Construction started on	Completed on	Time in days
1977			
1	5.4.77	27.4.77	22
2	6.4.77	28.4.77	22
14	10.4.77	29.4.77	19
17	15.4.77	6.5.77	21
19	15.4.77	5.5.77	20
29	17.4.77	8.5.77	21
32	28.4.77	16.5.77	18
43	1.5.77	16.5.77	15
1978			
1	20.4.78	10.5.78	20
13	21.4.78	10.5.78	19
15	21.4.78	13.5.78	22
26	22.4.78	12.5.78	20
38	29.4.78	17.5.78	18
39	15.5.78	31.5.78	16
40	22.5.78	4.6.78	13
44	26.5.78	6.6.78	11
46	1.6.78	9.6.78	8
59	3.6.78	10.6.78	7
1979			
1	21.4.79	12.5.79	21
18	13.5.79	30.5.79	17
25	16.5.79	2.6.79	17
36	20.5.79	3.6.79	14
46	26.5.79	6.6.79	11
48	24.5.79	5.6.79	12
69	2.6.79	10.6.79	8

The nest

The finished nest is a rough, round or elongated dome approximately 60-80 cm wide and approximately 35 to 50 cm high with a circular side opening 6-8 cm in diameter (Plate V, fig. 23). More often than not, the dome is slightly elongated. The opening usually faces the fork (Plate V, fig. 24). The dome is made up of an assortment of twigs, stems of grasses, shrubs and creepers, elongated leaf petioles, twine, strings, rags, pieces of paper, cellophane and aluminium foil wrappers, strips of rexine, pieces of polythene bags and sundry materials of similar type. The inside or the egg chamber is made up of similar but thinner and softer materials.

Occasionally a nest may be deserted, while still under construction, or even after completion for security reasons. Rarely is a nest deserted

after a full clutch has been laid ; on the other hand it is sure to be deserted if all the eggs are removed. The materials from the deserted nest are often utilized in the construction of the new nest.

The same nest may be used, after slight repairs, for raising the second brood after the first brood has been successfully raised.

CLUTCH

Time lapse between completion of the nest and laying of the first egg

The time lag between the completion of the nest and laying of the first egg could not be ascertained beyond doubt because of the dome like structure of the nest with narrow opening making visual observation rather difficult. It was generally observed that after the construction activity ceased or almost stopped the first egg was not laid immediately. Usually it was laid after 1 to 3 days of the stoppage of work on the nest (Table 8). But in some nests the lining of the egg chamber continued even after the first egg had been laid. In a few cases the full clutch was laid in an open nest and the dome was constructed later. In three cases (out of approximately 220 nests studied) the eggs were laid and hatched in an open nest without any attempt at constructing the dome.

TABLE 8. *Time lapse between the completion of the nest and laying of first egg*

Nest No.	Nest completed on	1st egg laid on	Time lapse (in days)
1975			
1	8.5.75	11.5.75	3
2	14.5.75	16.5.75	2
6	9.5.75	10.5.75	1
9/1	8.5.75	9.5.75	1
13	13.5.75	15.5.75	2
15	13.5.75	15.5.75	2
16	19.5.75	20.5.75	1
18	24.5.75	25.5.75	1
2/A	24.5.75	25.5.75	1
1976			
2	18.5.76	19.5.76	1
3	6.5.76	8.5.76	2
4	6.5.76	7.5.76	1
5	19.5.76	20.5.76	1
7	19.5.76	21.5.76	2
8	21.5.76	22.5.76	1
9	23.5.76	24.5.76	1
10	15.5.76	17.5.76	2
12	26.5.76	27.5.76	1
13	9.6.76	10.6.76	1

Nest No.	Nest completed on	1st egg laid on	Time lapse (in days)
1977			
1	27.4.77	29.4.77	2
2	28.4.77	30.4.77	2
14	29.4.77	30.4.77	1
17	6.5.77	8.5.77	2
19	5.5.77	6.5.77	1
29	8.5.77	9.5.77	1
32	16.5.77	17.5.77	1
43	16.5.77	18.5.77	2
1978			
1	10.5.78	13.5.78	3
13	10.5.78	12.5.78	2
15	13.5.78	14.5.78	1
26	12.5.78	14.5.78	2
38	17.5.78	18.5.78	1
39	31.5.78	2.6.78	2
40	4.6.78	5.6.78	1
44	6.6.78	7.6.78	1
46	9.6.78	10.6.78	1
59	10.6.78	11.6.78	1
1979			
1	12.5.79	15.5.79	3
18	30.5.79	31.5.79	1
25	2.6.79	4.6.79	2
36	3.6.79	5.6.79	2
46/A	6.6.79	7.6.79	1
48	5.6.79	7.6.79	2
69	10.6.79	11.6.79	1

Laying pattern

As already stated, normally, the egg laying starts shortly after the nest construction activity almost stops. Generally four to five and occasionally three or six eggs are also laid at regular intervals of twenty four hours (Table 9).

TABLE 9. *Laying pattern*

Nest No.	First egg laid on	Second egg laid on	Third egg laid on	Fourth egg laid on	Fifth egg laid on	Sixth egg laid on
2A/75	25.5.75	26.5.75	27.5.75	28. 5. 75	—	—
6/75	10.5.75	11.5.75	12.5.75	13.5.75	14.5.75	—
9/1/75	9.5.75	10.5.75	11.5.75	12.5.75	13.5.75	—
13/75	15.5.75	16.5.75	17.5.75	18.5.75	—	—
16/75	20.5.75	21.5.75	22.5.75	23.5.75	24.5.75	—
17/75	4.5.75	5.5.75	6.5.75	7.5.75	8.5.75	9.5.75
18/75	25.5.75	26.5.75	27.5.75	28.5.75	29.5.75	—
2/76	19.5.76	20.5.76	21.5.76	22.5.76	—	—

Nest No.	First egg laid on	Second egg laid on	Third egg laid on	Fourth egg laid on	Fifth egg laid on	Sixth egg laid on
3/76	8.5.76	9.5.76	10.5.76	11.5.76	12.5.76	13.5.76
4/76	7.5.76	8.5.76	9.5.76	10.5.76	11.5.76	12.5.76
5/76	20.5.76	21.5.76	22.5.76	23.5.76	—	—
7/76	21.5.76	22.5.76	23.5.76	24.5.76	25.5.76	—
8/76	22.5.76	23.5.76	24.5.76	25.5.76	—	—
9/76	24.5.76	25.5.76	26.5.76	27.5.76	—	—
10/76	17.5.76	18.5.76	19.5.76	20.5.76	21.5.76	—
12/76	27.5.76	28.5.76	29.5.76	30.5.76	—	—
13/76	10.6.76	11.6.76	12.6.76	13.6.76	—	—
1/77	29.4.77	30.4.77	1.5.77	2.5.77	3.5.77	—
2/77	30.4.77	1.5.77	2.5.77	3.5.77	4.5.77	—
17/77	8.5.77	9.5.77	10.5.77	11.5.77	—	—
19/77	6.5.77	7.5.77	8.5.77	9.5.77	10.5.77	—
32/77	17.5.77	18.5.77	19.5.77	20.5.77	—	—
43/77	18.5.77	19.5.77	20.5.77	21.5.77	—	—
13/78	12.5.78	13.5.78	14.5.78	15.5.78	16.5.78	17.5.78
15/78	14.5.78	15.5.78	16.5.78	17.5.78	18.5.78	—
26/78	14.5.78	15.5.78	16.5.78	17.5.78	18.5.78	19.5.78
38/78	18.5.78	19.5.78	20.5.78	21.5.78	—	—
40/78	5.6.78	6.6.78	7.6.78	8.6.78	9.6.78	—
44/78	7.6.78	8.6.78	9.6.78	10.6.78	—	—
46/78	10.6.78	11.6.78	12.6.78	13.6.78	—	—
59/78	11.6.78	12.6.78	13.6.78	—	—	—
1/79	15.5.79	16.5.79	17.5.79	18.5.79	—	—
18/79	31.5.79	1.6.79	2.6.79	3.6.79	4.6.79	—
25/79	4.6.79	5.6.79	6.6.79	—	—	—
36/79	5.6.79	6.6.79	7.6.79	8.6.79	9.6.79	—
46/79	7.6.79	8.6.79	9.6.79	10.6.79	—	—
48/79	7.6.79	8.6.79	9.6.79	10.6.79	—	—

Time of laying

The eggs were laid in the early forenoon (6 A. M. to 8 A. M.) in 81.25% of the nests. In 15.1% of the nests the eggs were laid during the afternoon. The individual time of laying and the period of twenty four hours was, however, maintained in all cases (Table 10).

TABLE 10. *Time of laying*

Egg found on visit on	Nest Nos.	Total nests
6.00 hrs to 8.00 hrs	6/75, 13/75, 16/75, 18/75 2/76, 3/76, 4/76, 5/76, 7/76 9/76, 10/76, 12/76, 1/77, 2/77, 17/77, 19/77, 43/77, 13/78, 15/78, 26/78, 40/78, 46/78, 1/79, 25/79, 48/79	26
10.00 hrs to 12.00 hrs	8/76	1
19.00 hrs to 21.00 hrs	9/1/75, 13/76, 32/77, 38/78, 36/79	5

Clutch size

Four or five eggs are generally laid but sometimes three or six eggs are also met with. Out of a total of 261 clutches observed during the period of study, thirty two (12.26%) consisted of 3 eggs each, one hundred and twenty nine (49.42%) consisted of 4 eggs each, eighty one (31.03%) consisted of 5 eggs each and only nineteen (7.27%) consisted of 6 eggs each. The mean clutch size for the years 1975, 1976, 1977, 1978 and 1979 was 3.9, 3.8, 3.9, 3.9 and 3.8 respectively (Tables 11 to 15). Monthly mean clutch size for these years has been shown in Table 16.

TABLE 11. *Clutch-size as observed in 1975 (May, June and July)*

Month	Number of clutches of				Mean clutch size
	3	4	5	6	
May	—	20	12	3	4.5
June	4	10	4	—	4.0
July	2	1	—	—	3.3
Total	6	31	16	3	3.9
Percentage	10.7	55.3	28.5	5.3	

TABLE 12. *Clutch-size as observed in 1976 (May, June and July)*

Month	Number of clutches of				Mean clutch size
	3	4	5	6	
May	—	18	14	4	4.6
June	5	9	3	—	3.9
July	1	—	—	—	3.0
Total	6	27	17	4	3.8
Percentage	11.1	50	31.4	7.4	

TABLE 13. *Clutch-size as observed in 1977 (May, June and July)*

Month	Number of clutches of				Mean clutch size
	3	4	5	6	
May	—	16	15	5	4.7
June	4	9	3	—	3.9
July	3	1	—	—	3.2
Total	7	26	18	5	3.9
Percentage	12.5	46.4	32.1	8.9	

TABLE 14. *Clutch-size as observed in 1978 (May, June and July)*

Month	Number of clutches of				Mean clutch size
	3	4	5	6	
May	—	15	13	4	4.6
June	3	7	4	—	4.0
July	3	—	—	—	3.0
Total	6	22	17	4	3.9
Percentage	12.2	44.8	34.6	8.1	

TABLE 15. *Clutch-size as observed in 1979 (May, June and July)*

Month	Number of clutches of				Mean clutch size
	3	4	5	6	
May	—	17	10	3	4.5
June	4	6	3	—	3.9
July	3	—	—	—	3.0
Total	7	23	13	3	3.8
Percentage	15.2	50.0	28.2	6.5	

TABLE 16. *Monthly mean clutch size*

Year	Month	No. of clutches of	Mean clutch size.	Mean clutch size for the year
1975	May	35	4.5	
	June	18	4.0	3.9
	July	3	3.3	
1976	May	36	4.6	
	June	17	3.9	3.8
	July	1	3.0	
1977	May	36	4.7	
	June	16	3.9	3.9
	July	4	3.2	
1978	May	32	4.6	
	June	14	4.0	3.9
	July	3	3.0	
1979	May	30	4.5	
	June	13	3.9	3.8
	July	3	3.0	

Seasonal variation

The above tables show that larger clutches containing five eggs were laid more frequently in the first half of the breeding season. This resulted in increase in the average clutch-size and also in the number of maximum clutches in the first half of the breeding season, reaching its peak by the last week of May. A gradual decline sets in the

number of larger clutches as well as in the number of clutches laid by the middle of June ; and the average clutch-size goes down to its lowest by early July.

EGGS

Shape :

The eggs of Indian Pied Myna are ovoid in shape ; one end is rounded and the other little tapered (Plate VII, fig. 27).

Colour :

The colour is blue, the shade may vary slightly from clutch to clutch. The shell is fairly glossy and devoid of any markings (Plate VII, fig. 27).

Size :

One hundred and seventy six eggs were measured for the average size which was found 27.41×20.32 mm (Table 17). This compared favourably with Baker's (1933) average 27.6×20.2 mm for 100 eggs.

TABLE 17. *Size of the eggs (Sturnus contra contra Linn.)*

Breadth in milimeter	Length in millimeter								
	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5
18.5	3	1	—	—	—	—	—	—	—
19.0	4	3	5	4	—	—	—	—	—
19.5	7	5	4	4	—	3	5	4	—
20.0	4	5	3	8	4	5	3	3	1
20.5	—	4	—	3	9	4	—	2	6
21.0	—	—	5	7	4	7	6	3	—
21.5	—	—	—	—	5	3	4	—	—
22.0	—	—	—	—	—	5	5	4	2

Weight :

On the average the eggs weighed 5.627 grams each (maximum 6.391 grams, minimum 4.974 grams). The average weight was lowest (5.567 grams) in 1978 and highest (5.691 grams in 1979 (Table 18).

TABLE 18. *Weight of eggs of the Indian Pied Myna during 1975-1979*

Year	No. of eggs	Weight in grams								Mean
		4.9	5.1	5.3	5.5	5.7	5.9	6.1	6.3	
1975	55	4	7	6	9	11	8	7	3	5.601
1976	58	3	8	8	11	9	10	7	2	5.586
1977	61	5	9	5	10	10	12	9	1	5.588
1978	71	—	10	12	18	14	9	8	—	5.567
1979	73	1	—	13	15	17	12	15	—	5.691
	318	13	34	44	63	61	51	46	6	5.627

A detailed study of comparative weights of successive eggs was undertaken in a limited number of 10 clutches. The study revealed that whereas there were indications of the second egg having a tendency to be heavier than the first the rest of the picture was too confused for any conclusion (Table 19).

TABLE 19. *Comparative weights of fresh successive eggs in 10 clutches*

S. No. of clutch (in grams)	Egg No.	Weight at laying (in grams)	Average weight per clutch
I	1	4.974	5.847
	2	5.307	
	3	5.259	
	4	5.851	
II	1	5.507	6.064
	2	6.007	
	3	6.090	
	4	6.891	
	5	6.327	
III	1	5.451	5.744
	2	5.709	
	3	5.699	
	4	5.971	
	5	5.892	
IV	1	4.992	5.061
	2	5.106	
	3	5.203	
	4	5.007	
	5	5.001	
V	1	5.601	5.684
	2	5.699	
	3	5.728	
	4	5.710	
VI	1	5.807	6.018
	2	6.178	
	3	6.089	
	4	6.001	
VII	1	5.562	5.741
	2	5.610	
	3	5.920	
	4	5.818	
	5	5.799	
VIII	1	5.109	5.858
	2	5.211	
	3	5.377	
	4	5.206	
	5	5.621	
	6	5.599	

TABLE 19. (*concluded.*)

S. No. of clutch (in grams)	Egg No.	Weight at laying (in grams)	Average weight per clutch
IX	1	5.900	6.070
	2	6.170	
	3	6.002	
	4	6.211	
X	1	5.216	5.601
	2	5.827	
	3	5.422	
	4	5.678	
	5	5.926	

Determinate layer

If one or more eggs are removed from a completed clutch the Indian Pied Myna does not lay any more eggs ; neither does it stop laying more eggs if the clutch is artificially completed by adding eggs.

INCUBATION

Definition :

The incubation is the application of heat to the eggs for the development of the embryo. The Indian Pied Myna incubates in the normal bird fashion by sitting on the clutch.

Commencement :

The female starts sitting in the nest during the daytime after the full clutch has been laid. She, however, starts spending the nights in the nest even a day or two before laying the first egg. Although she always starts sitting in the nest during the night, from the laying of the first egg it is doubtful if she applies any heat during the first one or two nights. This fact is revealed by the hatching pattern, and is discussed under that head.

Share of sexes :

The incubation, for the most part is done by the female. The male hangs around the nest while the female is incubating (Plate VII, fig. 28). He may go out for short feeding trips. On his return from such trips he usually intimates his arrival to his spouse either by calling or peeping into the nest. He relieves her occasionally for short feeding trips. Occasionally she may even call the male for such a relief (Plate VIII, fig. 30). During this time he may stay in the nest or outside. It could not

be ascertained whether or not he incubates during the time he is inside the nest. At night the female alone sits in the nest. The details of incubational reliefs as observed in two nests with marked birds from 05.30 to 20.00 hours are detailed below. On an average the share of the male in incubation works out roughly to 25%, whereas that of the female to 75%.

On hot afternoons the female may leave the nest and join her mate in a shady branch of the nesting tree (Plate VIII, fig. 29).

Mate recognition appears to be audiovisual. On the slightest hint of danger the male, who keeps to the vicinity of the nest, gives out an alarm call. In response to his alarm call the female invariably leaves the nest. But she does not do so when a neighbour gives out a similar alarm call. Following a record of daily schedule of activities of a pair from dawn till dusk.

Nest No. 4/76, date 15. 5. 76

5.40 hours	Female leaves the nest with the first light of dawn. Male appears and perches near the nest.
6.30 hours	Male settles in the nest.
7.20 hours	Female arrives, male leaves the nest.
7.22 hours	Female settles in the nest.
11.15 hours	Male arrives, female leaves the nest, sits near the male.
11.20 hours	Male settles in the nest and female takes off.
12.40 hours	Female arrives and perches near the nest. Male also leaves the nest and joins the female perched near the nest.
12.50 hours	Female settles in the nest.
17.30 hours	Male arrives and takes over from the female.
19.10 hours	Female arrives, male comes out the nest and perches in a nearby branch with female.
19.25 hours	Female occupies the nest.
20.00 hours	Female still sitting in the nest.

Nest No. 26/78, date 25. 5. 78

5.30 hours	Female leaves the nest and sits on the nesting branch.
5.50 hours	Male comes to the nesting branch.
6.10 hours	Male occupies the nest, female takes off.

7.30 hours	Female comes back.
7.31 hours	Male leaves the nest.
7.32 hours	Female settles in the nest.
12.10 hours	Male arrives to the nesting tree.
12.12 hours	Female leaves the nest and both male and female perches in a nearby branch.
12.40 hours	Male occupies the nest. Female takes off.
15.05 hours	Female arrives. Male takes off immediately. Female occupies the nest.
18.10 hours	Male arrives, female leaves the nest and male occupies the nest.
19.15 hours	Female arrives. Male leaves the nest and joins her on the nesting branch.
19.27 hours	Male takes off.
19.29 hours	Female settles in the nest.
20.00 hours	Female still sitting in the nest.

Period of incubation and hatching pattern

The eggs hatch out after 14-15 days (Table 20) more or less in the same order in which they are laid. The time gap between the laying of the last egg to the hatching of the same has been taken as period of incubation.

Eggs hatch out at irregular intervals of four to twenty hours, the first two hatchings are out on the same day within six hours of each other. That indicates that the regular incubation does not get under way till the second or the third egg is laid.

TABLE 20. *Period of incubation and hatching pattern*

Nest No.	Egg. No.	Laid on	Hatched on	Period in days
2A/75	1	25.5.75	9.6.75	15 days
	2	26.5.75	10.6.75 morn.	15 days
	3	27.5.75	10.6.75	14 days
	4	28.5.75	10.6.75 night	14 days
9/1/75	1	9.5.75	unhatched	—
	2	10.5.75	25.5.75	15 days
	3	11.5.75	25.5.75 even.	15 days
	4	12.5.75	26.5.75	14 days
	5	13.5.75	unhatched	—

TABLE 20. *Continued.*

Nest No.	Egg No.	Laid on	Hatched on	Period in days
13/75	1	15.5.75	30.5.75	15 days
	2	16.5.75	31.5.75	15 days
	3	17.5.75	31.5.75	14 days
	4	18.5.75	1.6.75 even.	14 days
16/75	1	20.5.75	4.6.75 even.	16 days
	2	21.5.75	5.6.75	15 days
	3	22.5.75	5.6.75 even.	15 days
	4	23.5.75	damaged	—
	5	24.5.75	6.6.75 even.	14 days
18/75	1	25.5.75	damaged	—
	2	26.5.75	10.6.75	15 days
	3	27.5.75	10.6.75 even.	15 days
	4	28.5.75	unhatched	—
	5	29.5.75	12.6.75 morn.	14 days
4/76	1	7.5.76	24.5.76	17 days
	2	8.5.76	24.5.76	16 days
	3	9.5.76	25.5.76	16 days
	4	10.5.76	25.5.76	15 days
	5	11.5.76	25.5.76 even.	15 days
	6	12.5.76	26.5.76	14 days
10/76	1	17.5.76	3.6.76	17 days
	2	18.5.76	3.6.76	16 days
	3	19.5.76	3.6.76	15 days
	4	20.5.76	4.6.76	15 days
	5	21.5.76	4.6.76	14 days
19/76	1	10.6.76	25.6.76 even.	16 days
	2	11.6.76	26.6.76	15 days
	3	12.6.76	26.6.76 even.	15 days
	4	13.6.76	27.6.76	14 days
1/77	1	29.4.77	15.5.77	16 days
	2	30.4.77	unhatched	—
	3	1.5.77	16.5.77	15 days
	4	2.5.77	17.5.77	15 days
	5	3.5.77	17.5.77	14 days
2/77	1	30.4.77	unhatched	—
	2	1.5.77	17.5.77	16 days
	3	2.5.77	17.5.77	15 days
	4	3.5.77	18.5.77	15 days
	5	4.5.77	18.5.77	14 days
17/77	1	8.5.77	23.5.77	15 days
	2	9.5.77	24.5.77	15 days
	3	10.5.77	24.5.77	14 days
	4	11.5.77	25.5.77	14 days

TABLE 20. *Continued.*

Nest No.	Egg No.	Laid on	Hatched on	Period in days
19/77	1	6.5.77	23.5.77	17 days
	2	7.5.77	23.5.77	16 days
	3	8.5.77	23.5.77	15 days
	4	9.5.77	unhatched	—
	5	10.5.77	24.5.77	14 days
32/77	1	17.5.77	1.6.77	15 days
	2	18.5.77	2.6.77	15 days
	3	19.5.77	2.6.77	14 days
	4	20.5.77	3.6.77	14 days
43/77	1	18.5.77	2.6.77	15 days
	2	19.5.77	3.6.77	15 days
	3	20.5.77	3.6.77	14 days
	4	21.5.77	4.6.77	14 days
13/78	1	12.5.78	29.5.78	17 days
	2	13.5.78	29.5.78	16 days
	3	14.5.78	30.5.78	16 days
	4	15.5.78	30.5.78	15 days
	5	16.5.78	unhatched	—
	6	17.5.78	31.5.78	14 days
15/78	1	14.5.78	unhatched	—
	2	15.5.78	31.5.78	16 days
	3	16.5.78	31.5.78	15 days
	4	17.5.78	1.6.78	15 days
	5	18.5.78	1.6.78	14 days
26/78	1	14.5.78	31.5.78	17 days
	2	15.5.78	31.5.78	16 days
	3	16.5.78	1.6.78	16 days
	4	17.5.78	1.6.78	15 days
	5	18.5.78	2.6.78	15 days
	6	19.5.78	2.6.78	14 days
38/78	1	18.5.78	2.6.78	15 days
	2	19.5.78	3.6.78	15 days
	3	20.5.78	3.6.78	14 days
	4	21.5.78	4.6.78	14 days
40/78	1	5.6.78	22.6.78	17 days
	2	6.6.78	22.6.78	16 days
	3	7.6.78	22.6.78	15 days
	4	8.6.78	23.6.78	15 days
	5	9.6.78	23.6.78	14 days
44/78	1	7.6.78	22.6.78	15 days
	2	8.6.78	23.6.78	15 days
	3	9.6.78	23.6.78	14 days
	4	10.6.78	24.6.78	14 days

TABLE 20. *Concluded.*

Nest No.	Egg No.	Laid on	Hatched on	Period in days
46/78	1	10.6.78	25.6.78	15 days
	2	11.6.78	26.6.78	15 days
	3	12.6.78	26.6.78	14 days
	4	13.6.78	27.6.78	14 days
59/78	1	11.6.78	26.6.78	15 days
	2	12.6.78	26.6.78	14 days
	3	13.6.78	27.6.78	14 days
1/79	1	15.5.79	30.5.79	15 days
	2	16.5.79	31.5.79	15 days
	3	17.5.79	unhatched	—
	4	18.5.79	1.6.79	14 days
18/79	1	31.5.79	damaged	—
	2	1.6.79	16.6.79	15 days
	3	2.6.79	17.6.79	15 days
	4	3.6.79	18.6.79	15 days
	5	4.6.79	18.6.79	14 days
25/79	1	4.6.79	unhatched	—
	2	5.6.79	19.6.79	14 days
	3	6.6.79	20.6.79	14 days
36/79	1	5.6.79	22.6.79	17 days
	2	6.6.79	22.6.79	16 days
	3	7.6.79	22.6.79	15 days
	4	8.6.79	23.6.79	15 days
	5	9.6.79	23.6.79	14 days
46/79	1	7.6.79	22.6.79	15 days
	2	8.6.79	23.6.79	15 days
	3	9.6.79	23.6.79	14 days
	4	10.6.79	24.6.79	14 days
43/79	1	7.6.79	22.6.79	15 days
	2	8.6.79	23.6.79	15 days
	3	9.6.79	23.6.79	14 days
	4	10.6.79	24.6.79	14 days

TABLE 21. *Eggs that did not hatch*

Nest No.	No. of eggs in the clutch	Egg No. that did not hatch
9/1/75	5	I and V
18/75	5	IV
1/77	5	II
2/77	5	I
19/77	5	IV
13/78	6	V
15/78	5	I
1/79	4	III
25/79	3	I

Hatching success

Hatching success was found to be fairly high. In the year 1975 it was observed to be 87%, in the year 1976 it was found to be 88%, in the year 1977 it was found to be 92% and in the year 1978 and 1979 it was found to be 89% (Table 22).

TABLE 22. *Hatching success*

Year	Nest No.	Eggs laid	Eggs hatched	Total hatched %
1975	2	4	4	nearly 87% average
	6	5	did not hatch	
	9/1	5	3	
	9/2	3	3	
	10	5	5	
	13	4	4	
	15	5	5	
	16	4	4	
	17	6	6	
	18	4	3	
	19	6	6	
	20	3	3	
	22	6	6	
1976	2	4	4	nearly 88% average
	3	6	6	
	4	6	6	
	6	5	5	
	10	5	5	
	11	5	1	
	13	4	4	
	14	5	4	
	15	5	5	
	16	4	3	
1977	1	5	4	nearly 92% average
	2	5	4	
	5	5	5	
	7	4	4	
	8	5	5	
	10	4	4	
	11	5	5	
	13	4	4	
	14	6	5	
	15	5	5	
	17	4	3	
	19	5	4	
	24	5	4	

TABLE 22. *Concluded.*

Year	Nest No.	Eggs laid	Eggs hatched	Total hatched%
1978	28	4	4	nearly 89% average
	29	4	4	
	32	4	4	
	43	4	4	
	13	6	5	
	14	5	5	
	15	5	4	
	26	6	6	
	28	5	5	
	32	5	3	
	37	4	3	
	38	4	4	
	40	5	5	
	42	5	4	
	44	4	4	
	46	4	4	
1979	50	5	4	89% average
	59	3	3	
	1	4	3	
	4	5	5	
	7	5	4	
	9	4	4	
	14	5	5	
	18	5	4	
	23	4	4	
	25	3	2	
	29	4	4	
	36	5	5	
	41	4	3	
	45	4	3	
	46	4	4	
	49	4	3	
	55	4	4	
	59	4	4	

The unhatched eggs were removed by the parents five to eight days after the hatching of last egg.

NEST LIFE

Physical features and weight at hatching

The hatchlings are nidicolous, fleshy pink in colour and almost naked. They have a yellow bill and gape, the tip of the bill is hard and eyes are closed. There are greyish white filoplumes on head,

back, wings, thighs and sides of abdomen (Plate IX, fig. 31, 32 and Plate X, fig. 33). The hatchlings are unable to stand up. They are however, able to raise their necks and gape their bills for food shortly after hatching.

The freshly hatched young weigh slightly less (0.475 to 0.528 grams average of 67 : 0.506 grams) than the weight of the egg, before hatching. Average weight of 67 hatchlings was found to be 5.123 grams.

Brooding, care and feeding of the young

The newly hatched young are kept warm especially during the night (also during the day for the 1st couple of days) by the mother and protected from hot sun during the day by both the parents who takes turns at brooding especially in open nests. The day brooding stops after 6 to 8 days after the hatching is completed. The night brooding however, continues for about 16-18 days. Even when the hatchlings are about to fly the females spends the night with them in the nest. The young, specially in the earlier stages, are never left unguarded. One of the parents is always around the nest to protect them from predators, rain or hot sun.

The earliest attempts to feed the young are made when they are about 6 to 12 hours old. The young are fed with insects larvae, soft-bodied insects, spiders etc. to begin with (Plate X, fig. 34), which are poured down their gullets by the parents. Both parents bring food for and feed the young, the female exerting herself more than the male.

Food and rate of feeding

The feeding activity starts in earnest after 24 hours of first hatching. It increases as more and more nestlings hatch out and demand for food. The parents make hurried trips to fetch something edible. The peak of this activity reaches by the end of 1st week and is, more or less, maintained for 5 to 6 days. Both the parents are kept under great pressure by the constant demand of food by the 4 or 5 fledglings they are raising. As many as thirty to forty four trips an hour by both parents were recorded on a number of occasions. In a six hour observation the feeding trips averaged thirty five trips an hour for a single pair. Soft and semi-solid food is put in the gullet of the young ones during this period. As the young grow they are able to swallow more and more solid food. Regurgitated grain is added to the bill of fare at this stage. This tends to reduce slightly the number of feeding trips by the parents. When the chicks are two weeks old they may be fed, or they accept food, four times in an hour at the maximum. After the 17th/18th

day the rate of feeding declines gradually till the nestlings are about 3 weeks old. After the 3rd week nestlings are fed only once or twice an hour, till the fledglings start accompanying the parents on feeding trips (Fig. 6).

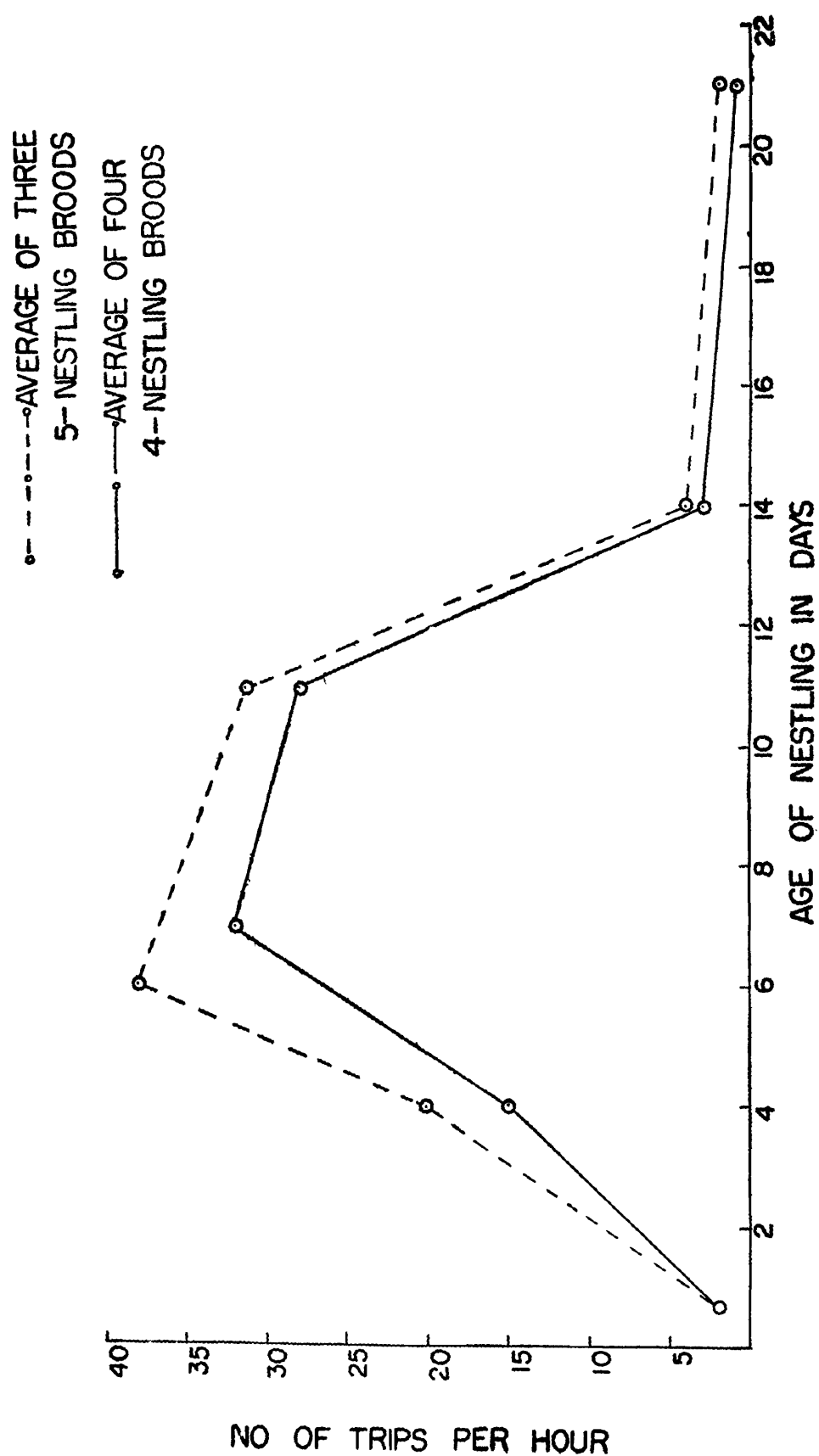


Fig. 6

Fledglings at the age of $2\frac{1}{2}$ weeks demand food on the arrival of the parent by coming out of the nest and perching on a branch nearby. The young leave the nest/nesting tree after they are about $3\frac{1}{2}$ week old. They then join their parents on feeding trips within or close to their territory. This association lasts for 8-12 days. After that the young part company with the parents. On such feeding trips both the parents supply food to the chicks for the first few days, later only one parent mostly the female keeps up the task of feeding the fledglings.

The solids on which the chicks are fed include whole insects, cereals, whole grains and a large variety of cooked food, thrown away by human community.

Nest sanitation

The Indian Pied Myna keeps the nest clean and tidy to a great extent. After the hatching out of the young, the egg shell is removed by the parents. The faeces of the young is enclosed in a delicate faecal sac. At every trip, after feeding the young the parent waits for the young to eject the faecal sac. If and when ejected, the sac is devoured by the parents, especially during the earlier days. Both sexes share the work of nest sanitation. As the young grow in age and acquire mobility they start coming out of the nest and elevate their hind quarters at the edge of the entrance hole at time of ejection. The faecal matters drops thus under the nesting tree. This participation by youngsters in the nest sanitation normally starts after the age of $2\frac{1}{2}$ weeks and continues till the time of their departure.

Growth of the nestling

The weight of the nestling at hatching is slightly (0.506 grams) less than the egg from which it emerges. Very little feeding is done during the first 24 hours, the nestling does not gain more than 2 to 4 grams in weight during this period. With the increase in feeding from the second day the gain in weight increases rapidly varying between 3 to 5 grams a day till the nestling is about 8 to 10 days old when it reaches about 40 to 45 grams. In the second week, the rate of growth in weight is somewhat retarded, varying between 2 to 4 grams a day. In the third week the rate of increase in weight is reduced to 12 to 16 grams for the whole week and during the fourth week the gain in bodyweight is at its lowest i.e. 5 to 10 grams. In the fourth week, nestling at the time of leaving the nest, weighs on the average 78.5 grams (Fig. 7). The rate of growth of weight is always higher and quicker in the nests when the number of fledgling is small.

TABLE 23. *Weight of young in nest*

Age in days	1st young		2nd young		3rd young		4th young	
	No. of cases	Average wt. in grams	No. of cases	Average wt. in grams.	No. of cases	Average wt. in grams.	No. of cases	Average wt. in grams
.25	17	4.947	20	5.409	12	5.135	18	5.001
1	17	8.142	20	8.406	12	7.909	18	7.811
2	21	11.509	18	11.857	17	10.206	16	10.085
3	19	14.498	17	14.791	17	13.670	14	13.997
4	20	16.986	20	17.075	18	16.861	16	15.566
5	20	20.562	19	20.907	17	19.899	15	18.997
6	14	24.000	14	24.560	12	23.277	12	22.806
7	15	29.200	10	29.507	10	27.882	9	27.679
11	10	48.260	8	49.933	8	46.221	8	45.511
14	12	56.682	10	58.981	9	54.976	7	54.276
18	10	71.862	8	73.621	6	70.811	4	70.327
24	16	78.500	10	79.415	5	77.955	2	76.829

The eldest fledgling generally reaches its 40 grams in weight in about 8 days while the youngest does so in about 10 days time. The youngest, however, catches up in 22 to 24 days (Table 23).

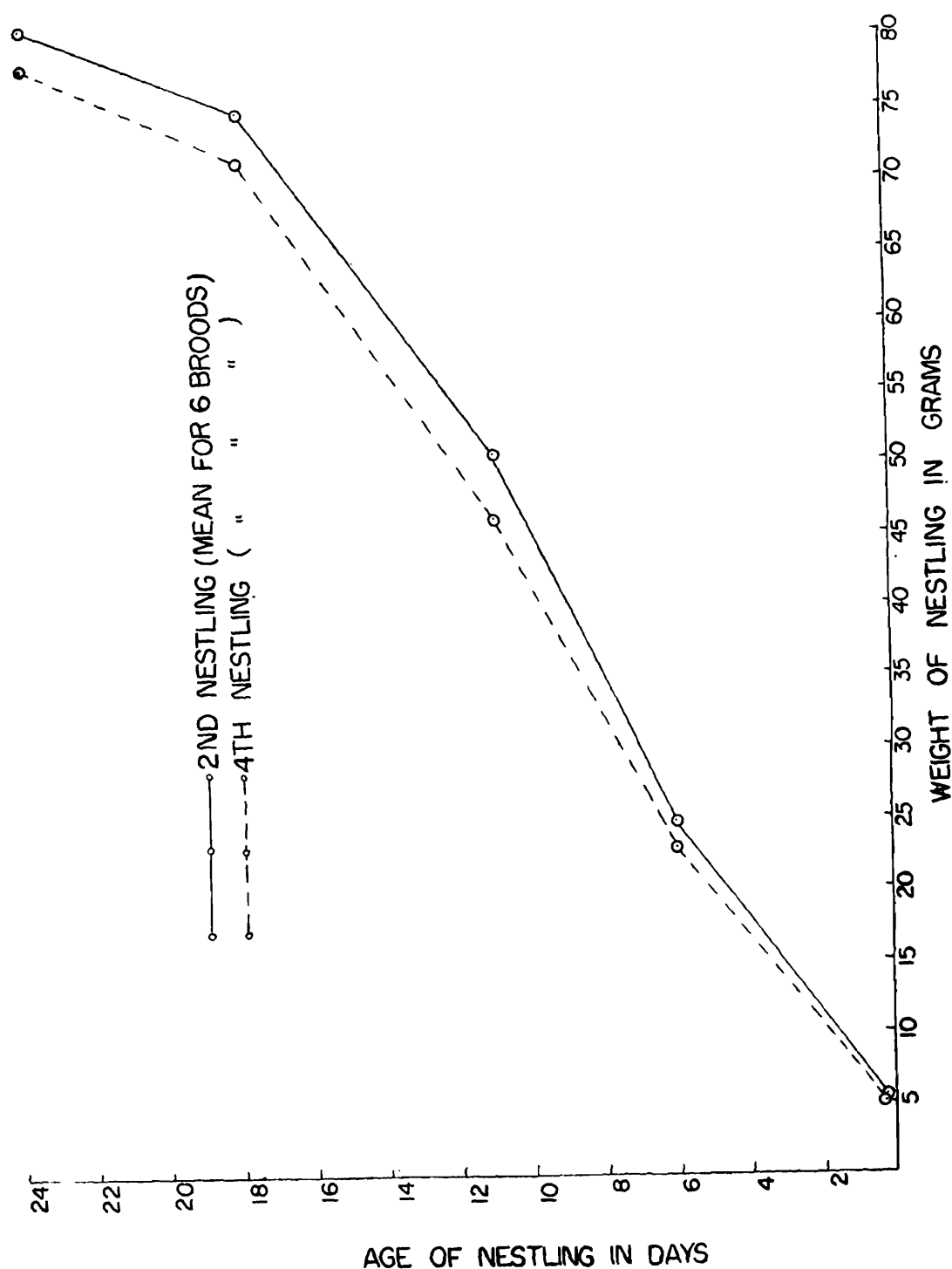


Fig 7.

Donning of feathers

The nestling on emergence is naked but for a few faint traces of down on the mid-dorsal, pelvic and femoral tracts and filoplumes in the wing and tail margins. When the young one is about four days old the dorsal and ventral feather tracts become prominent (Figs. 8, 9 and 10). With the passage of time the wing, tail and body feathers make their appearance. Descriptions of chicks at various ages showing the different stages of development of feathers were recorded and are given here.

Six days old young

Eyes partially open. Body colour fleshy pink. Feather making first appearance on dorsal tracts. Skin on the head between and around the

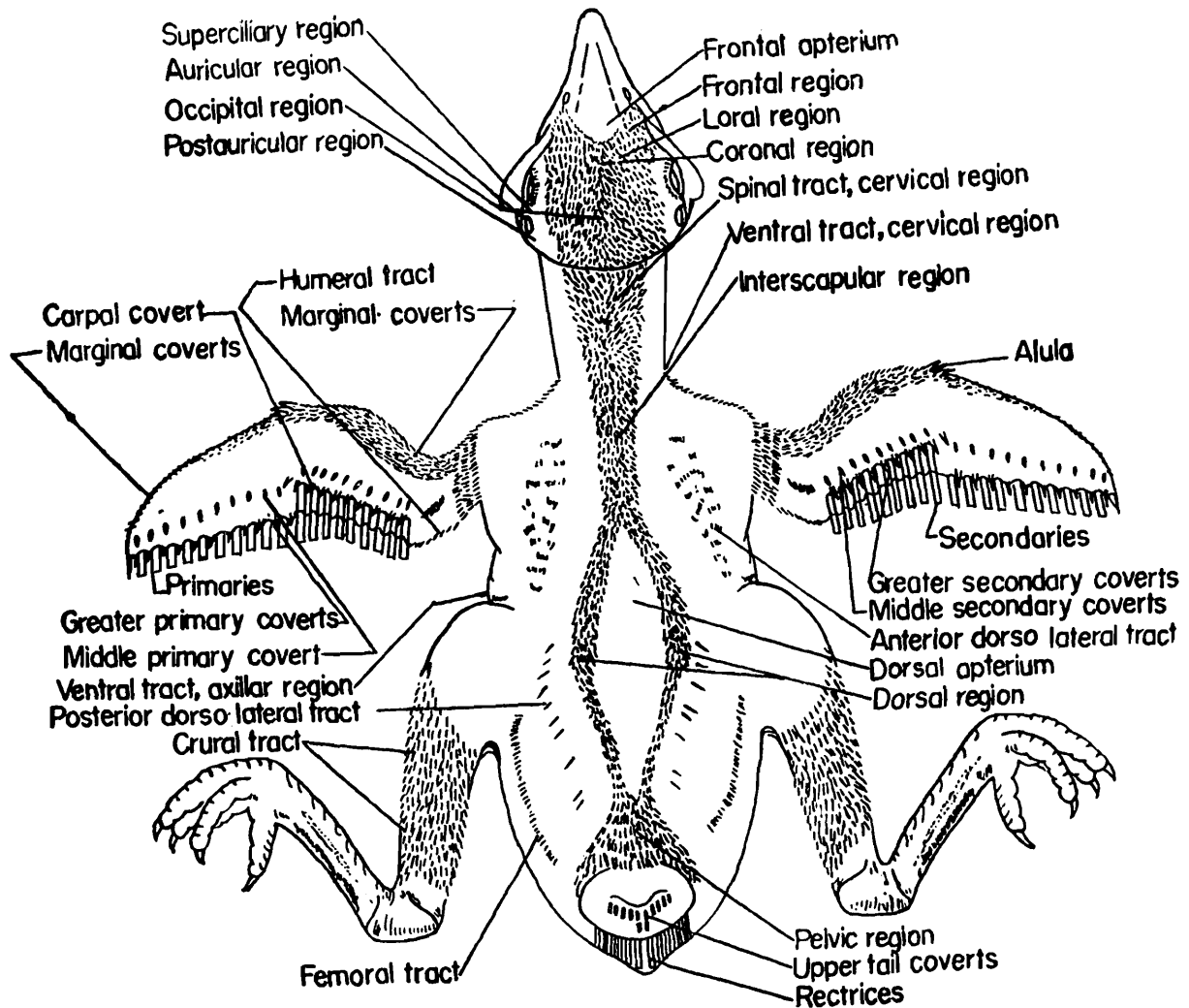


Fig. 8.

eyes gray, wing feathers have appeared in the form of needle-like structure, size 3 mm to 5 mm. Body feathers on lateral and ventral tracts emerging in the form of minute needle-like structure. Filoplumes in the shape of hairs still present over dorsal, ventral and lateral tracts. Scattered needle like structures are coming out over the posterior part of the body. Tail feathers coming out, maximum size 2 mm. Beak near the tip yellow, back half of beak grayish. Legs dark pink grayish (Plate XI, figs. 35 and 36).

13-14 days old young

Body almost covered with feathers. The skin under the wings on dorsolateral sides naked except for a few needle-like hairs. The colour of the skin fleshy pink. The dorsal tract fully covered with black hair

like feathers of 0.7 cm to 0.9 cm size. The head and neck covered with needle-like feathers of 0.4 cm to 0.7 cm size. The colour of beak dark brown. Dorsolateral and ventral feather tracts covered with white hairy needle-like feathers. The colour of feathers of dorsal tract near the tail white. The tail feathers black and gray brush-like structure of 1 cm to 2.2 cm size. Legs covered with grayish feathers. Ventral side partially covered with white hairy feathers of 0.4 cm to 0.6 cm (Plate XII, fig. 37).

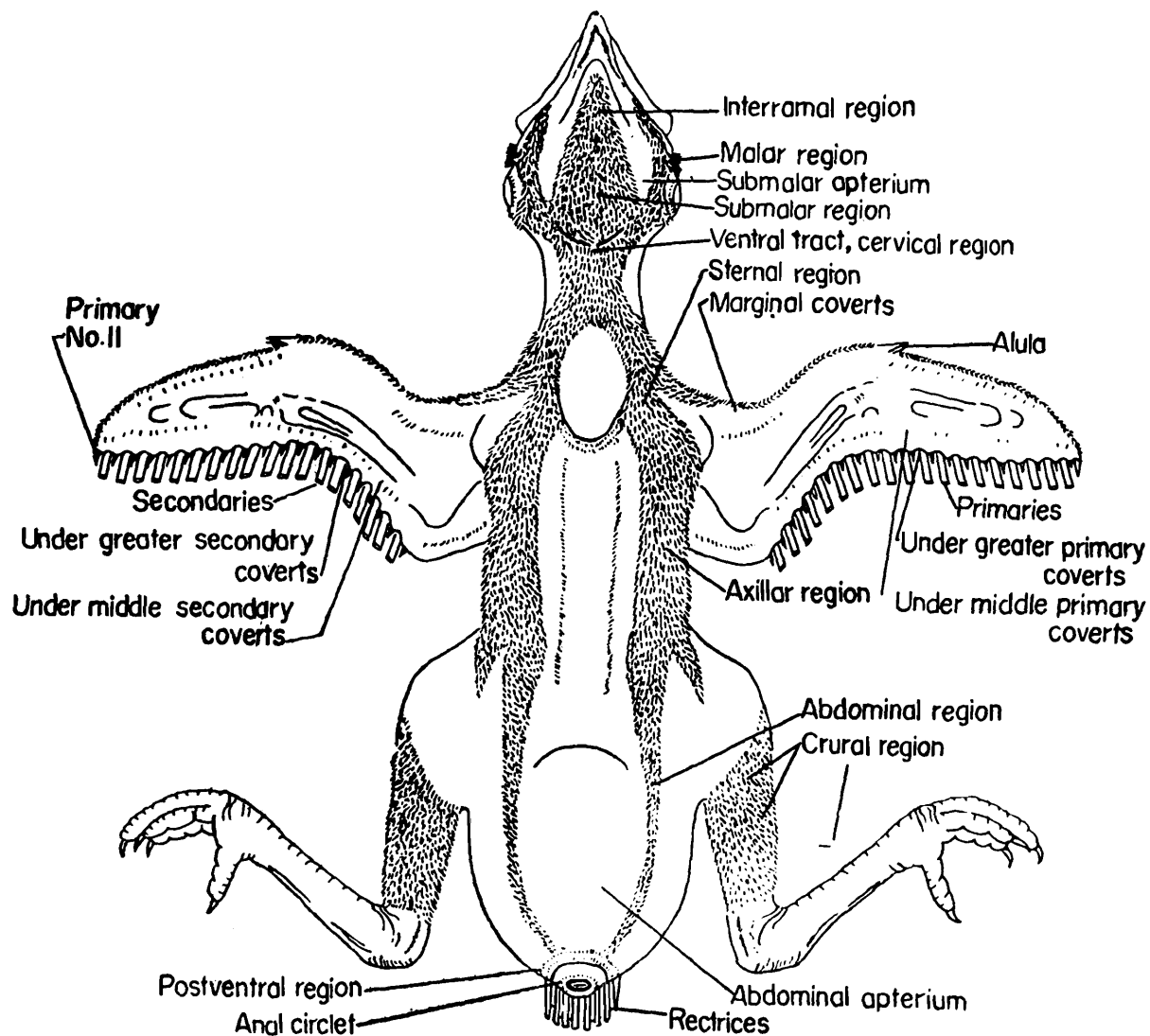


Fig. 9

Eighteen days old young

No bare skin visible, body all covered by feathers, colour of plumage somewhat like adult bird though not as bright. Wing feathers approximately 5.5 cm to 8 cm in length. Tail feathers approximately 3 cm long. Edge of the gape still yellow. Rest of the gape whitish. Most of the beak black, tip of the beak lighter, legs black, weight 72 grams (Plate XIII, figs. 38 and 39).

Behaviour of the nestlings

For the first four or five days the eyes of nestling are closed. During this period if a soft noise is made near the nest, or on the rim of the

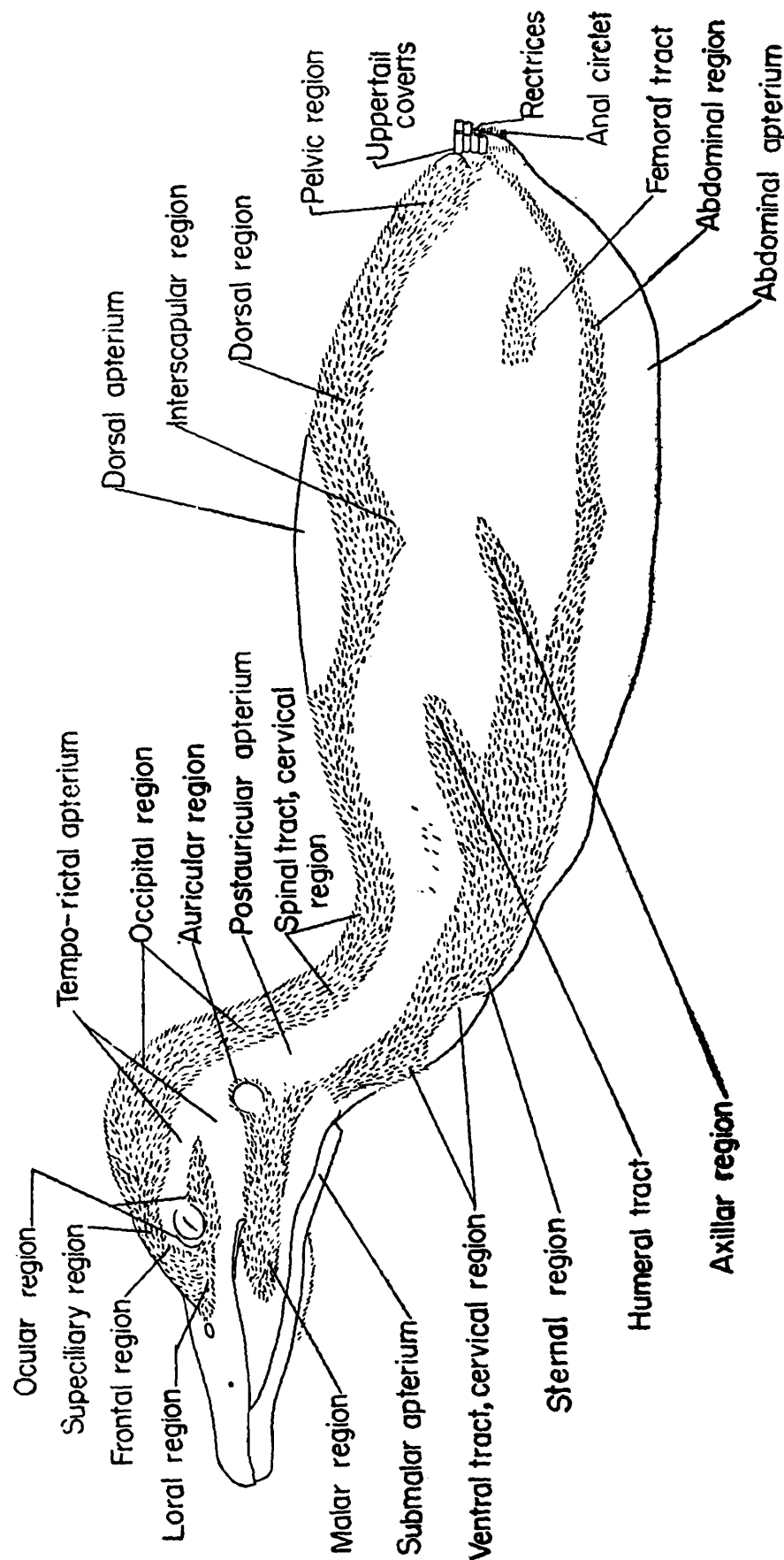


Fig. 10.

nest hole the nestlings react to it by raising their necks and gaping for food. This food response continues even after their eyes open. The eyes open between the 5th and the 8th day. The fear complex develops after a day or two of opening the eyes. After the opening of the eyes the nestlings start discriminating between the visit of a parent and an intruder. At about the same time they start responding to the alarm calls of the parents. On the approach of an intruder or in response to the alarm call, the nestling moves deeper inside the nest and may even cling to the lining if handled. The parent offspring recognition also seems to be audiovisual. At the age of 18-20 days the young ones leave the nest or the nearby branch on which they may be perching at the approach of an intruder. They may move to higher branches in the same tree or to a nearby tree if capable of doing so. The parents invariably give out a danger call at the sight of an intruder or a predator and they too leave the nest immediately, but remain in the vicinity.

After leaving the nest, which they usually do at the age of 21-25 days the young accompany their parents for about 8-12 days. The parents lead them around in their territory, feed them, and possibly demonstrate to them how to pick up food. It is presumed that the young part company with their parents after they are capable of feeding independently.

Length of nestling period

At the age of 21-25 days most young ones leave the nest. A few weaker ones (usually the last to hatch) may however, stay on two three days more (Table 24).

TABLE 24. *Length of nestling period*

Year	Nest. No.	Last chick hatched on	Last chick left on	Period in days
1975	2A	10.6.75	4.7.75	24
	18	1.6.75	26.6.75	25
	16	6.6.75	30.6.75	24
	18	12.6.75	7.7.75	25
1976	4	26.5.76	16.6.76	21
	10	4.6.76	26.6.76	22
	13	27.6.76	22.7.76	25
1977	17	25.5.77	16.6.77	22
	19	24.5.77	14.6.77	21
	43	4.6.77	26.6.77	22

TABLE. 24. *Concluded.*

Year	Nest. No.	Last chick hatched on	Last chick left on	Period in days
1978	15	1.6.78	28.6.78	27
	26	2.6.78	29.6.78	27
	38	4.6.78	27.6.78	23
	44	24.6.78	15.7.78	21
1979	25	20.6.79	14.7.79	24
	36	23.6.79	14.7.79	21
	46	24.6.79	17.7.79	23
	59	24.6.79	20.7.79	26
Average				23.5

Nestling mortality

Like all the eggs that are laid do not hatch, all the young that hatch out do not live to leave the nest. Out of 895 nestlings that hatched out in 221 nests, as many as 399 died in the nest. The mortality, therefore, works out roughly as 44.59% (Table 25).

TABLE 25. *Nestling mortality*

Year	No. of nests observed	No. of eggs hatched	No. of fledglings that flew out of the nest	No. of , fledglings that died	Percentage
1975	44	170	97	73	43%
1976	52	213	115	98	46%
1977	41	164	95	69	42.1%
1978	36	150	78	72	48%
1979	48	198	111	87	44%
	221	895	496	399	44.59%

Most of deaths (32%) were due to falls on account of the nests being blown away by strong, gusty winds during freak pre-monsoon thunderstorms. The most important factor involved was perhaps the availability of food, rather lack of it. The majority of deaths occur in first week from want of food. When the fledglings are very young, the parents seem to make no discrimination whatever in feeding them. The parent on arrival at the nest with bill full of food in confronted with a number of gaping mouths as each of the nestling raises its neck and gapes widely. The parents stuffs the food into one of the gaping mouths, probably that which happens to be the nearest. This is

repeated at every visit of the parent. The young which are not fed until their stronger brethren have received all they can hold, start losing weight with the passage of time and soon become so weak that they cannot even raise their necks to demand food. The parents do not seem to take any notice of such weaklings, and certainly do not make any special attempts to feed them. The weakest thus go to the wall. The dead are thrown out by the parents without the slightest concern. Most of such deaths occur in the nests with 4 or five nestlings. About 18% of deaths occurred presumably on this account. Some of these deaths may have occurred on account of disease etc. also.

Nesting success :

As already indicated the nesting success in the Indian Pied Myna depends on a number of factors, the most important ones being the amount of food available for the young at the nesting stage, fertility of the eggs laid, interference by predators and deaths due to natural calamities like storms etc.

In the present study a total of 895 eggs were hatched in 221 nests. A total of 496 young left the nest (Table 26). The nesting success, therefore, comes to 55.4%.

TABLE 26. *Nesting success*

Year	No. of nest observed	No. of eggs hatched	No. of fledglings that flew out of the nest	Percentage
1975	44	170	97	57%
1976	52	213	115	54%
1977	41	164	95	57.9%
1978	36	150	78	52%
1979	48	198	111	56%
	221	895	496	55.4%

Second brood :

Some of the early breeders go in for the second brood. In such cases, invariably, the nesting pairs keep their territory after the first brood has left. They undergo the courtship routine once more. About seven days after the departure of the first brood the nesting pair starts repairing the old nest. The repairs may take about 3 to 5 days. Where the first nest is beyond repair or is blown off by strong wind etc. a new one is constructed within 7-9 days. Copulation is quite frequent

during this period. The egg laying sometimes starts while the nest is still being repaired or constructed. Three to four eggs are generally laid. Most eggs of the second brood were seen in the last week of June and first week of July (Table 27).

TABLE 27. *The dates of laying of eggs*

Nest No.	1st egg laid on	2nd egg laid on	3rd egg laid in	4th egg laid on
62/75	28.6.75	29.6.75	30.6.75	1.7.75
67/75	30.6.75	1.7.75	2.7.75	—
9/2/75	1.7.75	2.7.75	3.7.75	4.7.75
61/76	29.6.76	30.6.76	1.7.76	2.7.76
57/77	29.6.77	30.6.77	1.7.77	2.7.77
63/77	4.7.77	5.7.77	6.7.77	—
60/78	1.7.78	2.7.78	3.7.78	4.7.78
61/79	27.6.79	28.6.79	29.6.79	30.6.79
64/79	2.7.79	3.7.76	4.7.79	5.7.79
68/79	7.7.79	8.7.79	9.7.79	—

The incubation period and the nestling period for the second brood remains the same as in the first brood (Table 28).

TABLE 28. *The incubation period and hatching pattern*

Nest No.	Egg No.	Laid on	Hatched on	Period in days
62/75	1	28.6.75	13.7.75	15 days
	2	29.6.75	14.7.75	15 days
	3	30.6.75	14.7.75	14 days
	4	1.7.75	15.7.75	14 days
67/76	1	30.6.75	did not hatch	—
	2	1.7.75	15.5.75	14 days
	3	2.7.75	16.7.75	14 days
9/2/75	1	1.7.75	damaged	—
	2	2.7.75	17.7.75	15 days
	3	3.7.75	17.7.75	14 days
	4	4.7.75	18.7.75	14 days
61/76	1	29.6.76	14.7.76	15 days
	2	30.6.76	15.7.76	15 days
	3	1.7.76	15.7.76	14 days
	4	2.7.76	16.7.76	14 days
57/77	1	29.6.77	14.7.77	15 days
	2	30.6.77	15.7.77	15 days
	3	1.7.77	did not hatch	—
	4	2.7.77	16.7.77	14 days

TABLE 28. *Concluded.*

Nest No.	Egg. No.	Laid on	Hatched on	Period in days
63/77	1	4.7.77	19.7.77	15 days
	2	5.7.77	19.7.77	14 days
	3	6.7.77	20.7.77	14 days
60/78	1	1.7.78	16.7.78	15 days
	2	2.7.78	17.7.78	15 days
	3	3.7.78	17.7.78	14 days
	4	4.7.78	18.7.78	14 days
61/79	1	27.6.79	12.7.79	15 days
	2	28.6.79	13.7.79	15 days
	3	29.6.79	did not hatch	—
	4	30.6.79	14.7.79	14 days
64/79	1	2.7.79	17.7.79	15 days
	2	3.7.79	18.7.79	15 days
	3	4.7.79	18.7.79	14 days
	4	5.7.79	19.7.79	14 days
68/79	1	7.7.79	22.7.79	15 days
	2	8.7.79	22.7.79	14 days
	3	9.7.79	23.7.79	14 days

The rate of development of the young of the 2nd brood was slightly higher than that of the first brood.

The number of such second brooders is rather small. Only four pairs in 1975, one pair in 1976, three pairs in 1977, two pairs in 1978 and four pairs 1979 raised the second brood successfully. Some pairs viz. two in 1975 one in 1976, two in 1977, two in 1978 and three in 1979 started the nest repairs activity but failed to lay any eggs.

Out of the twenty one pairs that were banded during the period of study (1975-79) only five pairs raised a second brood. Three pairs raised the second brood in their original nests, one occupied a neighbour's deserted nest while one female not only constructed a new nest but also acquired a new mate.

Sturnus pagodarum (Gmelin)

The Brahminy Myna

BREEDING SEASON

Number of seasons and duration :

The Brahminy Myna has a single breeding season of about six months from early March to end of August.

Most males occupy their territories by the second week of March. Pair formation, in most cases is completed by March end or beginning of April.

The maximum number of nests under construction were observed during second half of April and first half of May. Most of the eggs were observed during the second half of May, and most of the nests with fledglings were observed from end of May to June.

The raising of a second brood is a common phenomenon. Most of the eggs of the second brood were observed during the latter half of June and the first half of July. The nestlings from the second brood start to lead an independent life by the end of August.

MATING

Pair formation

Early in the breeding season, small flocks of Brahminy Myna, usually seen feeding and roosting in non-breeding season, sort themselves out in pairs. The criteria involved in the process of selection of partners could not be studied. Presumably audiovisual cues lead to the determination of individual attraction and compatibility. The partners are sought out and courted. Pairs once formed remain together for the total duration of the breeding season. A new mate is acquired only in the event of the death of a partner. In four cases when the female was shot dead during the early nest construction stage three male acquired new females, while the fourth abandoned the territory.

Courtship behaviour

Courting consists mainly of feeding together and courtship display. During courtship display the male starts singing and stands erect on the grass. He puffs up his plumage, throws back his head, raises his black crest, while his tail fans out and touches the ground. Normally this courtship display is performed when the female is standing close by hardly exhibiting any excitement. After the display the male may mount if the female is willing. Sometimes the female does not take notice of this display and keeps on feeding or preening herself nonchalantly.

Copulation

The courtship display of the male when responded to by the female always ends in copulation. Copulation takes place mostly on the ground, sometimes in branches of tree and roofs of house. This is performed in the normal bird fashion. Copulation is most frequent

while the nest site is being selected and or the nest is being constructed. The frequency of copulation is highest (four times in four hours) during nest-building stage. The frequency of copulation decreases as the clutch is being laid, and ceases completely after the start of incubation. After the departure of the first brood the copulation is resumed again and its frequency reaches its peak when the arrangements (nest repair, construction etc) for the second brood are in progress. The partners resume the same activity (feeding or construction of nest) after the copulation.

Number of mates

The Brahminy Myna is observed to be strictly monogamous. Only one female is courted by a single male. After the copulation takes place confirming the pair bond no advances are made by either sex to other individuals of the opposite sex. They live together, love and care for each other and behave like the true partners for the total duration of the bond (one breeding season).

Duration of Bond

Two individuals of opposite sexes (in Brahminy Myna) join up to form a pair for one breeding season only. The pairs which emerge out of the flocks return to form flocks after the end of breeding season. Both the males and the females of two pairs were banded in order to determine the duration of bond in 1978. One pair could not be traced next year. The male and female of the second pair, paired up with different birds in 1979. On the basis of these observations no definite conclusion can be arrived at.

TERRITORY

'Territory' is established by the male quite early in the breeding season. The territory is announced by the male by a pleasing little warbling song delivered from a shady perch in the nature of a soliloquy with his crest partially raised. This song, presumably attracts the female. Sometimes the announcement of the territory is made by the mere presence of the male or the pair.

The territory is defended by both the partners against all others of the same species and other species like Common Myna, Jungle Babbler, Green Barbet and Magpie Robin etc.

Size

The size of the territory apparently depends upon the intraspecific competition and the availability of the suitable nesting sites. The

availability of the nesting holes is probably more important of the two. Twelve artificial nest boxes were provided in different trees in a single compound measuring 4000 sq. metres at distances varying from four to twenty metres. Almost all of them were occupied. In nature the size of the territory was observed to be much larger viz. 90 to 200 sq. metres. But this again, perhaps depends upon the availability of suitable nest holes in the trees and walls etc.

Defence

Entry of others of the species or other hole nesting species viz. intruder like the Common Myna, Jungle Babbler, Magpie Robin etc. are strongly resented by the owners of the territory. The male guards its territory or nest during whole of the breeding season. The male pounces upon the intruder at sight. Generally this sudden dash or pounce is enough to make the intruder flee. If the intruder refuses to flee, he or she is physically assaulted. Beak and claws are the main weapons of offence and defence. This show of force generally ends up in the withdrawal of the intruder. Where the intruder is too large or too powerful (Birds of prey, monkey or man) to be driven away by assault the owners keep flying over head protesting all the while. If the intruder does not leave even then, the owners perch in a nearby tree and keep on calling agitatedly.

NEST CONSTRUCTION

Selection of site

The nesting site is apparently selected by common consent of both the partners. After the pair formation both the partners move about in their territory in search of a nesting site. Usually it is the location of a nest hole that attracts the male to the territory. The hole is shown to every visiting female. The one who likes and approves of it stays on. Otherwise the pair look for another nest hole within the territory or adjoining areas if still unoccupied. If no nest hole is found to the liking of the female she may break off with the male or the pair may desert the territory. In the year 1976 six wooden nest boxes (letter box type) of size 15×15×22 cms with the entrance holes of 4 cm each were nailed on trees in the compound of bungalow No. 13 at Subhash Road, Dehradun. Out of these, five were occupied by this species and one was occupied by a pair of Magpie Robin. After the success of these boxes, 12 such nest boxes were placed every year from 1977-79, which were all occupied by this species,

One of these nest boxes caught the fancy of a pair of Common Myna, (which is a slightly heavier bird). But they found the entrance hole too small for a comfortable entry and made unsuccessful attempts to enlarge it. In the process the pair perched on the box and pecked at the hole like a Wood Pecker. Realising the futility of their labour they gave up after two days. This box was eventually occupied by a Brahminy Myna.

The site selected may often be given up if considered unsafe. The concept of safety seemed to vary with various individuals/couples. Usually frequent visits from a cat, a raptor, a small boy climbing the nesting tree or frequent appearance of people on a roof or balcony very near to the nest hole was enough to induce desertion.

After the selection of the site in early breeding season, a few days time may elapse before the nest construction is taken up.

Situation and location of nest

In nature a hole in a tree or a wall is the most common nest site. Artificial nest sites like nest boxes provided at an height of 3 to 12 metres from the ground were preferred most for placing the nests in. A pair may take as long as 15 to 25 days in the selection of the nesting site and starting the construction of nest.

Nesting materials

The stems of small plants, thin and paliable twigs, pieces of string, strips of paper, rags, stem of creepers and twines, grass stems, feathers, cellophane paper and similar sundry materials are used in the construction of the base and outer lining of the nest.

The egg cavity, which is a slight depression in the platform like nest, is invariably constructed out of softer material, like very thin and paliable blades and stems of grasses. Occasionally thread, strips of soft paper or rag may also be used for this purpose.

The material hunting is done by both sexes generally from the ground under the trees, or from the hedges etc. from within the territory or adjoining areas.

Mode of construction and share of sexes

Both the sexes collect the materials for and take part in the construction of the nest. The female puts in more efforts than the male. The male generally helps in the collection of the materials and female does most of the construction. The female's material collecting trips are normally very close to the nest. When the nest construction

activity is at its peak the material hunting trips of both the sexes becomes more numerous and almost equal in frequency. Occasionally in the beginning and invariably at the end of the nest construction most of the material is collected by the female. The male mostly guards the territory. He does not contribute equally in the collection of material and construction of the nest. Once the construction of the nest is started the nest is never left unguarded. One or the other of the owners is always at hand to defend and protect it from intruders.

At times bigger twigs which are difficult to insert in the nest hole may cause a problem for the bird. The bird tries to insert this twig in the hole but it gets obstructed and falls on the ground below. Instead of giving up the birds picks it up again and tries to manoeuvre it inside (Plate XIV, fig. 40). It is only with great reluctance that such a twig is abandoned.

TABLE 29. *Time required for the completion of the nest*

Nest No.	Construction started on	Completed on	Time in days
1/76	2.5.76	19.5.76	17 days
2/76	3.5.76	21.5.76	18 days
7/76	5.5.76	23.5.76	18 days
11/76	2.5.76	20.5.76	18 days
14/76	3.5.76	20.5.76	17 days
3/77	8.5.77	23.5.77	15 days
9/77	14.5.77	27.5.77	13 days
15/77	14.5.77	29.5.77	15 days
19/77	21.5.77	2.6.77	12 days
4/78	6.4.78	29.4.78	23 days
13/78	9.4.78	1.5.78	22 days
15/78	24.4.78	14.5.78	20 days
16/78	13.5.78	27.5.78	15 days
1/79	1.4.79	26.4.79	25 days
6/79	1.4.79	25.4.79	24 days
8/79	21.4.79	12.5.79	21 days
9/79	1.5.79	19.5.79	18 days
18/79	15.5.79	27.5.79	12 days

The nest construction activity continues throughout the day. Only between 12.00 to 14.00 hours it becomes slower. It is at its peak between 10.00 and 12.00 hours and again between 14.00 to 16.00 hours. During the peak period the material hunting trips are made on an average of one every two minutes. During the slack period the rate of such trips falls to twelve minutes a trip on an average. On the approach

of an intruder the bird guarding the nest alerts the other partner, who might be busy inside the hole. The alert is sounded by an alarm call made from the vicinity of the entrance hole. On hearing the alarm call the bird working inside leaves the nest in a hurry.

Time required for the completion of the nest

Twelve to twenty five days time is spent generally in the construction of the nest (Table 29). The time taken depends upon the advancement of the breeding season. Birds that start constructing early in the breeding season take more time than those who start late in the season.

The nest

The completed nest is a rough circular pad-shaped structure with a central depression. The size of the nest depends upon the size of the hole in which it is located. In nest boxes the diameter of the pad varied from 11 to 13 cm. and the thickness of the pad measured from 10 to 12 cm. In the centre of the pad the egg chamber is prepared in the form of a round depression measuring about 4 to 6 cm. in diameter and 2-3 cm. in depth (Plate XIV, fig. 41).

The outer lining of the nest is made of comparatively hard twigs, stems of small creepers and twiners, grass stems etc. but the egg chamber is made up of softer materials like grass leaves, small grass stems, paper pieces, cloth strips lengths of hairs etc. The nest may sometimes be deserted while still under construction on the apprehension of danger from predators or oether aggressive hole nesting species. Normally the nest is not deserted after the full clutch has been laid. In the nest boxes the rate of nest desertation was very low. Only two pairs deserted out of the 42 studied. In three cases, when the whole clutches were removed for certain specified studies, the birds laid full clutches again instead of deserting the nest. Such second clutches were laid after 14-20 days of the removal of the first clutch.

Mostly the same nest is used for raising the second brood after the first brood has been successfully raised.

CLUTCH

Time lapse between the completion of the nest and the laying of the 1st egg

The time lag between the completion of nest and laying of first egg varies between 1-2 days of the work stoppage on the nest (Table 30). Occasionally the finishing touches to the egg chamber may continue even after the second egg has been laid.

TABLE 30. *Time lapse between the completion of the nest and laying of the first egg*

No of the Nest	Nest completed on	1st egg laid on	Time lapse (in days)
1/76	19.5.76	20.5.76	1
2/76	21.5.76	22.5.76	1
7/76	23.5.76	24.5.76	1
11/76	20.5.76	22.5.76	2
14/76	20.5.76	21.5.76	1
3/77	23.5.77	24.5.77	1
9/77	27.5.77	28.5.77	1
15/77	29.5.77	30.5.77	1
19/77	2.6.77	3.6.77	1
4/78	23.4.78	1.5.78	2
13/78	1.5.78	2.5.78	1
15/78	14.5.78	15.5.78	1
16/78	27.5.78	28.5.78	1
1/79	26.4.79	28.4.79	2
6/79	25.4.79	27.4.79	2
8/79	12.5.79	13.5.79	1
9/79	19.5.79	20.5.79	1
18/79	27.5.79	28.5.79	1

Laying pattern

Normally the egg laying starts after the completion of the nest, i. e. when the nest construction activity almost ceases. Generally four eggs and occasionally three and five eggs are laid at regular intervals of twenty four hours (Table 31).

TABLE 31. *The laying pattern*

Nest No.	First egg laid on	Second egg laid on	Third egg laid on	Fourth egg laid on	Fifth egg laid on
1/76	20.5.76	21.5.76	22.5.76	23.5.76	—
2/76	22.5.76	23.5.76	24.5.76	25.5.76	26.5.76
7/76	24.5.76	25.5.76	26.5.76	27.5.76	28.5.76
11/76	22.5.76	23.5.76	24.5.76	25.5.76	—
14/76	21.5.76	22.5.76	23.5.76	24.5.76	—
3/77	24.5.77	25.5.77	26.5.77	27.5.77	—
9/77	28.5.77	29.5.77	30.5.77	31.5.77	—
15/77	30.5.77	31.5.77	1.6.77	2.6.77	—
19/77	3.6.77	4.6.77	5.6.77	6.6.77	—
4/78	1.5.78	2.5.78	3.5.78	4.5.78	—
13/78	2.5.78	3.5.78	4.5.78	—	—
15/78	15.5.78	16.5.78	17.5.78	18.5.78	—
16/78	28.5.78	29.5.78	30.5.78	31.5.78	—
1/79	28.4.79	29.4.79	30.4.79	1.5.79	—
6/79	27.4.79	28.4.79	29.4.79	30.5.79	—
8/79	13.5.79	14.5.79	15.5.79	—	—
9/79	20.5.79	21.5.79	22.5.79	23.5.79	24.5.79
18/79	28.5.79	29.5.79	30.5.79	—	—

Time of laying

The egg were laid in the early forenoon from 6.00 to 9.30 hours. In only two nests the egg laying was observed from 15.00 to 18.00 hours. The individual time of laying and the interval of twenty four hours between laying of successive eggs was, however, maintained in all cases (Table 32).

TABLE 32. *Time of laying*

Egg found on visit on	Nest Nos.	Total nests
6.00 to 9.30 hours	1/76, 2/76, 7/76, 14/76 3/77, 9/77, 19/77, 4/78, 13/78, 15/78, 1/79, 6/79, 8/79, 18/79	14
15.00 to 18.00 hours	15/77, 19/79	2

Clutch size :

Four eggs are generally laid but occasionally three or five eggs are also met with. Out of a total of 121 clutches observed during the period of study twenty three (19%) consisted of eggs, eighty one (66.94%) consisted of four eggs and seventeen (14.05%) consisted of five eggs each. The mean clutch size for the year 1976, 1977, 1978, 1979 was 4.0, 3.8, 3.9 and 3.9 respectively (Table 33 to 36). Monthly mean clutch size for these years have been shown in Table 37.

TABLE 33. *Clutch-size as observed in 1976 (May, June and July)*

Month	Number of clutches of			Mean clutch size
	3	4	5	
May	—	7	2	4.2
June	—	2	—	4
July	1	4	—	3.8
Total	1	13	2	4.0
Percentage	6.25	81.25	12.5	

TABLE 34. *Clutch size as observed in 1977 (May, June and July)*

Month	Number of clutch of			Mean clutch size
	3	4	5	
May	1	12	4	4.1
June	1	3	—	3.7
July	4	7	—	3.6
Total	6	22	4	3.8
Percentage	18.75	68.75	12.5	

TABLE 35. *Clutch size as observed in 1978 (May, June, and July)*

Month	Number of clutches of			Mean clutch size
	3	4	5	
May	2	13	3	4.0
June	—	2	1	4.3
July	6	8	—	3.5
Total	8	23	4	3.9
Percentage	22.85	65.7	11.4	

TABLE 36. *Clutch size as observed in 1979 (April, May, June and July)*

Month	Number of clutches of			Mean clutch size
	3	4	5	
April	—	2	2	4.5
May	1	12	5	4.2
June	1	2	—	3.6
July	6	7	—	3.5
Total	8	23	7	3.9
Percentage	21	60.5	18.4	

TABLE 37. *Monthly Mean Clutch size*

Year	Month	No. of clutches	Mean clutch size	Mean clutch size for the year
1976	May	9	4.2	4.0
	June	2	4.0	
	July	5	3.8	
1977	May	17	4.1	3.8
	June	4	3.7	
	July	11	3.6	
1978	May	18	4.0	3.9
	June	3	4.3	
	July	14	3.5	
1979	April	4	4.5	3.9
	May	18	4.2	
	June	3	3.6	
	July	13	3.5	

Seasonal Variation

The above table shows that larger clutches containing four and five eggs were laid more frequently in the months of May and June. This resulted in an increase in the average clutch size and also in the number of maximum clutches in the first half of the breeding season, reaching its peak by the last week of May and the first week of June. A gradual decline sets in the number of larger clutches as well as in the number of clutches laid after the first week of June. Again a second peak reaches in the first and second weeks of July.

Eggs*Shape :*

The eggs of Brahminy Myna are ovoid in shape i. e. one end being broad and the other a little pointed (Plate XV, fig. 42).

Colour

The colour of the eggs is pale blue. The shade may vary slightly in different clutches. The shell is without any markings and fairly glossy (Plate XV, fig. 43).

Size

The average size of 103 eggs was found to be 24.5×19.0 mm (Table 38). This compared favourably with Baker's (1933) average 24.6×19.0 mm for 100 eggs.

TABLE 38. *Size of the eggs of sturnus pagodarum (Gmelin)*

Breadth in mm	Length in millimeter								
	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5
17.0	1	1	—	—	—	—	—	—	—
17.5	—	2	1	1	1	—	—	—	—
18.0	—	2	2	2	4	3	—	—	—
18.5	—	2	3	3	6	4	2	—	—
19.0	—	—	—	4	9	8	2	—	—
19.5	—	—	3	2	4	6	2	—	—
20.0	—	—	2	1	6	3	3	1	—
20.5	—	—	—	1	1	—	1	2	—
21.0	—	—	—	—	—	—	—	—	2

Weight

On an average the eggs weighed 5.039 grams each (maximum 5.906 grams, minimum 4.315 grams). The average weight was lowest (4.982 grams) in 1978 and highest (5.087 grams) in 1979 (Table 39).

TABLE 39. *Weight of eggs of the Brahminy Myna during 1976-1979*

Year	No. of eggs	Weight in grams									Mean
		4.3	4.5	4.7	4.9	5.1	5.3	5.5	5.7	5.9	
1976	25	2	3	3	4	5	3	2	2	1	5.020
1977	31	1	3	5	6	6	2	4	2	2	5.067
1978	29	2	4	3	7	5	2	4	2	—	4.982
1979	33	1	3	4	8	4	5	2	4	2	5.087
	118	6	13	15	25	20	12	12	10	5	5.039

A detailed study of comparative weight of successive eggs was undertaken in 10 clutches. The study revealed that there is no definite pattern of increase or decrease in the weight of the successive eggs laid (Table 40).

TABLE 40. *Comparative weights of fresh successive eggs in 10 clutches*

S. No. of Clutch	Egg No.	Weight at laying (in grams)	Average weight per clutch
I	1	4.682	4.592
	2	4.315	
	3	4.731	
	4	4.592	

TABLE 40. (*Continued*)

S. No. of Clutch	Egg No.	Weight at laying (in grams)	Average weight per Clutch
II	1	5.067	5.101
	2	5.123	
	3	5.110	
	4	5.106	
III	1	5.173	5.158
	2	5.026	
	3	5.237	
	4	5.199	
IV	1	4.471	4.429
	2	4.362	
	3	4.406	
	4	4.510	
	5	4.397	
V	1	5.906	5.844
	2	5.741	
	3	5.836	
VI	1	5.827	5.779
	2	5.799	
	3	5.713	
VII	1	5.124	5.190
	2	5.236	
	3	5.212	
VIII	1	4.912	5.047
	2	5.110	
	3	5.036	
	4	5.071	
IX	1	5.134	5.136
	2	5.101	
	3	5.092	
	4	5.235	
	5	5.122	
X	1	4.716	4.833
	2	4.901	
	3	4.882	

Determinate layer

In one or more eggs are removed from a complete clutch, the Brahminy Myna does not lay any more egg to complete it. If the clutch is completed artificially by adding eggs she does not stop laying more eggs.

Incubation

Commencement

The female starts spending the night inside the nest while it is still under construction. She starts spending the days, sitting on eggs, only after the laying of the second egg. As evident from the hatching pattern she, apparently, starts effective incubation only with the laying of the second egg.

Share of sexes

The female does most of the incubation. She spends the full night in the nest, and a major part of the day. The male guards the nest by perching in trees and other convenient spots nearby. When the female is incubating, he may leave for short feeding trips. On return from some feeding trips he brings food for the female also, whom he feeds through the nest hole. Even otherwise he normally informs his mate of his return by peeping into the nest. He relieves her occasionally for short feeding trips (Plate XVI, fig. 44). During the feeding trips of female, the male may enter the nest or may stay outside. Many a time the male may have to be called by the female for such relief. The incubational relief by male as observed in a nest box from 5.30 to 20.00 hrs on a single day worked out to be 20%.

During hot afternoons the female leaves the nest and joins the male in a shady branch of the nesting tree, or a nearby tree presumably leaving the incubation to atmospheric heat.

Mate recognition seems to be audiovisual. On the slightest hint of danger or interruption the male, who guards the nest, gives out an alarm call. In response to the warning of the male the female comes out of the nest hole. But if a neighbour makes such a call she simply peeps from the nest hole without making any attempt to fly out.

Incubation period and hatching pattern

After a period of incubation the eggs hatch out more or less in the order in which they are laid. The time lag between laying of the last egg and hatching of that egg has been taken as the incubation period which comes to twelve days. The eggs hatch out one after the other in the order of laying after intervals of 4 to 24 hours. This differs from clutch to clutch.

TABLE 41. *Incubation period and hatching pattern*

Nest No.	Egg No.	Laid on	Hatched on	Period in days
1/76	1	20.5.76	did not hatch	—
	2	21.5.76	2.6.76	12 days
	3	22.5.76	3.6.76	12 days
	4	23.5.76	4.6.76	12 days
2/76	1	22.5.76	5.6.76	14 days
	2	23.5.76	5.6.76	13 days
	3	24.5.76	5.6.76	12 days
	4	25.5.76	6.6.76	12 days
	5	26.5.76	7.6.76	12 days
7/76	1	24.5.76	did not hatch	—
	2	25.5.76	8.6.76	14 days
	3	26.5.76	8.6.76	13 days
	4	27.5.76	8.6.76	12 days
	5	28.5.76	9.6.76	12 days
3/77	1	24.5.77	7.6.77	14 days
	2	25.5.77	7.6.77	13 days
	3	26.5.77	8.6.77	13 days
	4	27.5.77	8.6.77	12 days
15/77	1	30.5.77	did not hatch	—
	2	31.5.77	13.6.77	13 days
	3	1.6.77	14.6.77	13 days
	4	2.6.77	14.6.77	12 days
19/77	1	3.6.77	17.6.77	14 days
	2	4.6.77	18.6.77	14 days
	3	5.6.77	18.6.77	13 days
	4	6.6.77	18.6.77	12 days
4/78	1	1.5.78	15.5.78	14 days
	2	2.5.78	15.5.78	13 days
	3	3.5.78	15.5.78	12 days
	4	4.5.78	16.5.78	12 days
13/78	1	2.5.78	15.5.78	13 days
	2	3.5.78	15.5.78	12 days
	3	4.5.78	16.5.78	12 days
15/78	1	15.5.78	29.5.78	14 days
	2	16.5.78	29.5.78	13 days
	3	17.5.78	29.5.78	12 days
	4	18.5.78	30.5.78	12 days
16/78	1	28.5.78	11.6.78	14 days
	2	29.5.78	11.6.78	13 days
	3	30.5.78	did not hatch	—
	4	31.5.78	12.6.78	12 days

TABLE 41. (*Concluded.*)

Nest No.	Egg No.	Laid on	Hatched on	Period in days
1/79	1	28.4.79	10.5.79	12 days
	2	29.4.79	11.5.79	12 days
	3	30.4.79	12.5.79	12 days
	4	1.5.79	13.5.79	12 days
6/79	1	27.4.79	11.5.79	14 days
	2	28.4.79	11.5.79	13 days
	3	29.4.79	12.5.79	13 days
	4	30.4.79	12.5.79	12 days
8/79	1	13.5.79	26.5.79	13 days
	2	14.5.79	26.5.79	12 days
	3	15.5.79	27.5.79	12 days
9/79	1	20.5.79	did not hatch	—
	2	21.5.79	3.6.79	13 days
	3	22.5.79	3.6.79	12 days
	4	23.5.79	4.6.79	12 days
	5	24.5.79	5.6.79	12 days

TABLE 42. *Eggs that did not hatch*

Nest No.	No. of eggs in the clutch	Egg No. that did not hatch
1/76	4	I
7/76	5	I
9/77	4	complete clutch
15/77	4	I
16/78	4	III
9/79	5	I

Hatching success :

Eggs that did not hatch are found to be the first egg in most of the cases. Only in one case it was the third egg. Only one whole clutch failed to hatch out during the course of this 4 years study. The bird deserted this clutch after incubating it for 20 days.

Hatching success was found to be fairly high. In the year 1976 it was observed to be 93%, in the year 1977 it was found to be 91% in the year 1978 it was observed to be 95% and in the year 1979 it turned out to be 94% (Table 43).

TABLE 43. *Hatching success*

Year	Nest No.	Eggs laid	Eggs hatched	Total hatched %
1976	1	4	3	93% (average)
	2	5	5	
	5	4	4	
	7	5	4	
	8	4	4	
	9	3	3	
	10	4	4	
	11	4	4	
1977	1	5	5	91% (average)
	2	4	4	
	3	4	4	
	5	3	3	
	9	4	not hatched	
	10	4	4	
	11	4	4	
	12	5	5	
	13	4	4	
	14	4	4	
	15	4	3	
	16	4	4	
	17	4	4	
1977	18	4	4	
	19	4	4	
	19	4	4	
1978	1	4	4	95% (average)
	4	4	4	
	10	4	4	
	13	3	3	
	15	4	4	
	16	4	3	
1979	1	4	4	94% (average)
	6	4	4	
	8	3	3	
	9	5	4	
	18	3	3	

The unhatched eggs were removed by the parents three to six days after hatching of the last egg.

Nest life

Physical features and weight at hatching

The newly hatched young are nidicolous. The colour of the body is fleshy pink. The eyes are closed. The gape is yellow. The tips of

claws and the beak are hard. The filoplumes are present on dorsal feather tract, on the nape, in the head region above the eyes, along the wings traces of flight feathers are visible. Filoplumes are also present on lateral feather tracts. Traces of yolk sac are visible through the almost transparent abdominal wall. The hatchlings are unable to stand up. They are, however, able to raise their necks and gape their bills for food shortly after the hatching (Plate XVI, fig. 45 ; Plate XVII, figs 46 and 47 and Plate XVIII, fig. 48).

The freshly hatched young are slightly less in weight (0.35 to .49 grams average of 42 : 0.41 grams) than the weight of the egg, before hatching. Average weight of 42 hatchlings was found to be 4.501 grams.

Brooding, care and feeding of the young :

The newly hatched young are covered by the mother in order to keep them warm at night and during the day too for the first few days. This day brooding stops after 5-6 days after the hatching is complete. The night brooding however, continues for about two weeks. The female spends the nights in the nest even when the nestlings are quite grown up and are about to fly. The young are guarded by the parents till they leave the nest. One of the parents always keeps a vigil for any possible danger to its young ones.

The feeding of the young by the parents starts soon after hatching. The young are fed on very soft food material like, insect larvae, spiders, earthworms etc. to start with (Plate XIX, fig. 49), which is pushed in their gullets by the parents. Both the parents procure food for and feed the young, but the female exerts herself more than the male.

Food and rate of feeding

The feeding of the young starts soon after the first hatching. The intensity of feeding increases in proportion to the increased demand of food by the nestlings as the number of nestlings increase. The parents collect food material hurriedly for the young. This activity reaches its peak when the nestlings are 5-6 days old and continues for another 4-5 days. Both the parents endeavour to meet the persistent demand of food by their young. On a number of occasions when the young ones were 8 to 10 days old the feeding trips of both the parents were recorded. As many as forty to forty five trips an hour (average of three hours) by both the parents were clocked. The ratio of such trips by the male and the female worked out to be 1 : 6 respectively. In the earlier stages the food consists of soft semi-solid animal matter. But

as the age of the young increases they are able to swallow more solid food. Regurgitated grains are given to the young by the parents when they are about 10 days old. As a result of the intake of comparatively solid food the number of feeding trips is reduced. After the age of

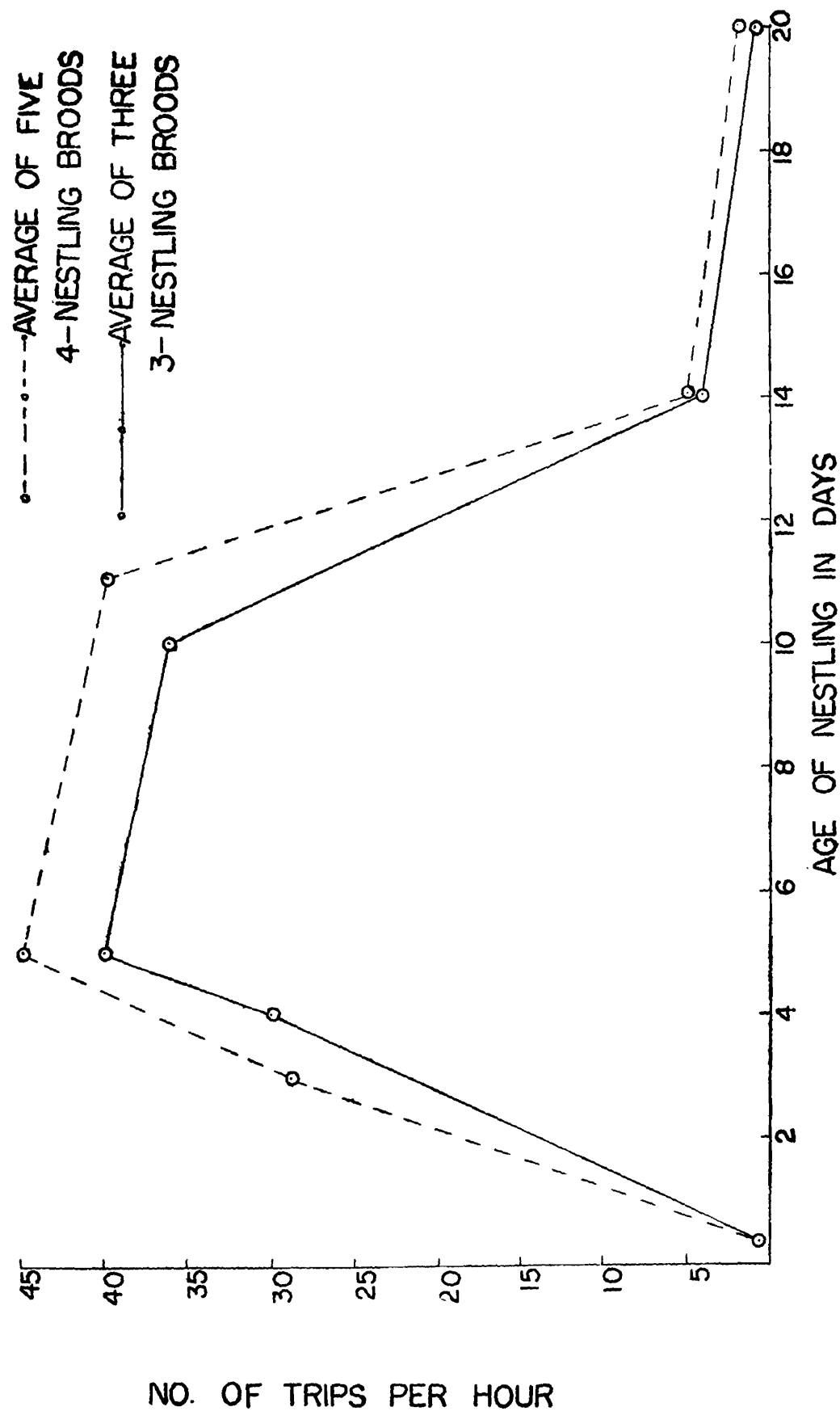


Fig. 11

12 days is attained each feed becomes larger. Consequently the food hunting trips become fewer gradually as the age of the young increases. At the age of about 2 week the young may be fed only four to five times an hour. When the chicks are 15 days old the rate of feeding decreases gradually. By 18th-20th day the rate of feeding drops down to mere once or twice an hour (fig. 11). When the fledglings are 14-15 days old they may extend their necks out of the nest hole to demand food on the arrival of the parents.

The young leave the nest at the age of 18-21 days. They then start accompanying their parents on feeding trips. This association with the parents continues for about 7 to 10 days, when they are finally weaned.

The solid food materials which are given to the young by the parents consist of insects, cereals and whole grain etc.

Nest sanitation

The nest is kept clean and orderly throughout the breeding cycle. The egg shell is removed by the parents soon after the hatching of the young. The faecal matter of the young, especially in the earlier stages is enclosed in a delicate transparent sheath and is ejected in the form of a pellet. After feeding the parents may wait the ejection of the faecal pellet by one of the young and may even induce its ejection by picking at the hind quarters of the young. The faecal pellet, if and when ejected, is carried by the parent and dropped 15-20 metre away from the nest (Plate XIX, fig. 50). The faecal pellets of the young are regularly removed by both the parents, especially in the earlier stages.

By the end of the second week, as the young acquire, mobility, they come up to the nest hole and elevate their hind quarters at the edge of the entrance hole at the time of ejection. Thus the faecal matter drops under the nesting tree. This sanitation by the young continues till the young depart from the nest.

Growth of the nestlings

The weight of the nestlings at the time of hatching is slightly (0.41 gram) less than the weight of egg from which it emerges. Nestlings do not gain much weight during first day because of very little feeding in the first twentyfour hours. On the second and third days when the rate of feeding accelerates, the gain in weight increases rapidly and the nestlings gain 3 to 5 grams daily. From the 4th day onwards and upto

roughly the 10th day the gain in the weight varies between 3 to 4 grams daily. A ten day old nestling weighs about 35 to 38 grams. In the second half of the second week the rate of growth is some what arrested, it varies between 1 to 2 grams a day. A sixteen day old young may weigh between 40 to 45 grams (Table 44, fig. 12). The average weight of the adult Brahminy Myna as described by Ali and Ripley (1972, Vol. 5 : 162) is 40-54 grams.

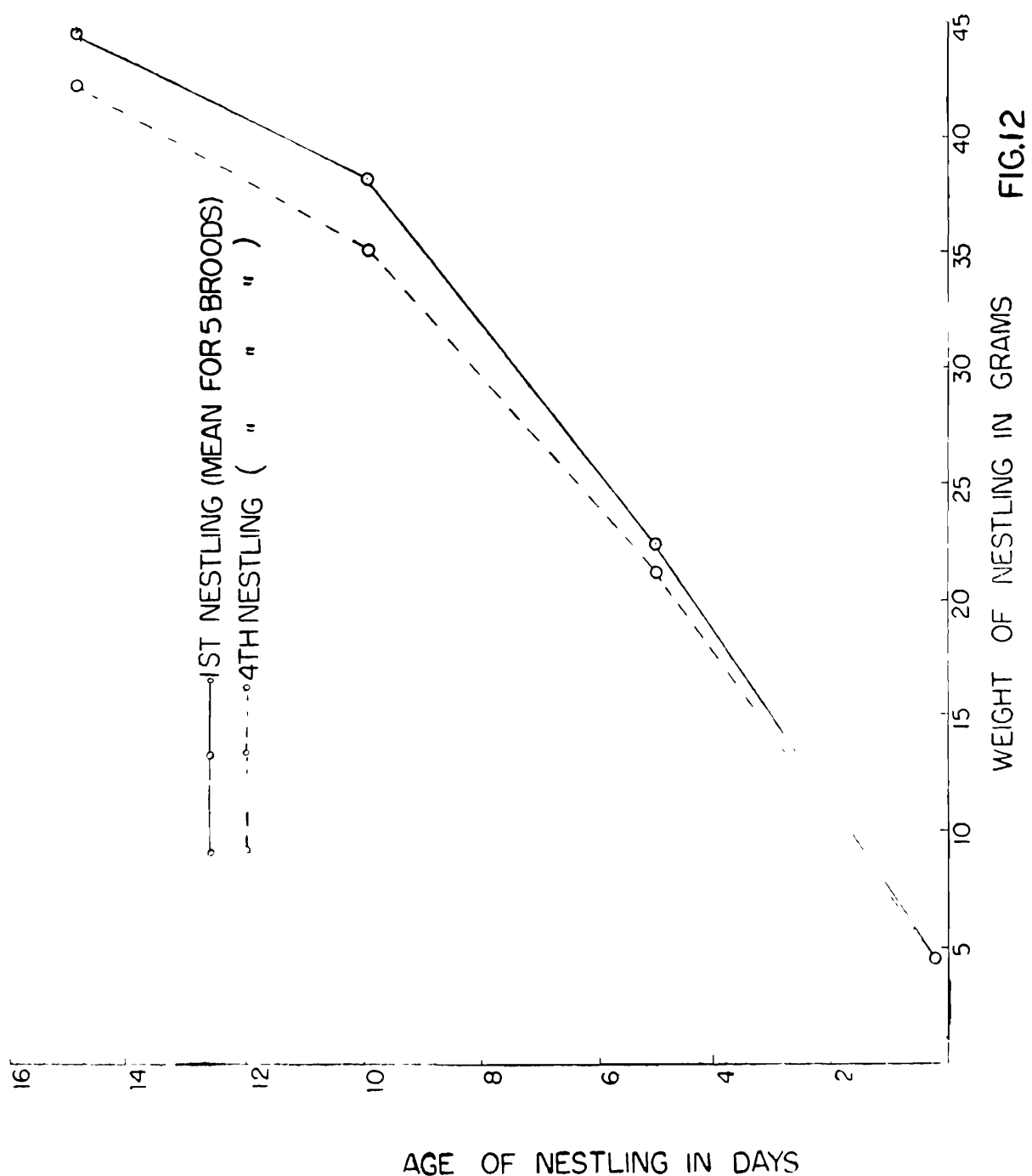


Fig. 12

TABLE 44. *Weight of the young in the nest*

Age in days	I young		II young		III young		IV young	
	No. of cases	Av. Wt. in gm.	No. of cases	Av. Wt. in gm.	No. of cases	Av. Wt. in gm.	No. of cases	Av. Wt. in gm.
25	11	4.509	11	4.506	10	4.496	10	4.502
1	11	6.002	11	6.109	10	5.997	10	5.913
2	10	9.947	10	9.426	10	8.821	10	9.001
3	10	14.310	10	14.002	10	12.702	10	12.972
4	9	17.804	9	17.799	9	17.101	8	16.436
5	9	22.300	9	22.007	9	21.261	8	21.109
6	9	25.867	9	25.231	9	24.862	8	23.997
7	9	27.762	9	27.549	9	27.121	8	26.862
8	9	30.507	9	30.002	9	29.722	8	29.135
9	8	34.993	8	33.908	7	32.231	7	31.991
10	8	38.002	8	37.116	7	35.674	7	35.001
13	8	42.610	8	41.901	7	39.702	7	38.526
15	8	44.102	8	43.827	7	42.851	7	41.942

Donning of feathers

The nestling at the time of hatching is nacked, except for a few faint traces of filoplumes on dorsal and lateral feather tracts. A few traces of flight feathers along the outer edge of fore arm are also visible. As the young one grows in age and is about three/four days old, the dorsal and ventral feather tracts become prominent (fig. 13 and 14). With the passage of time the wing, tail and body feathers make their appearance. The detailed description of the chick at various ages showing the different developmental stages of feathers were observed and are given below.

Eight days old young

Eyes are open, body colour is greyish pink. Filoplumes on dorsal tract are partially replaced by body feathers. Skin of head and nape is dark grey on account of sprouting of feathers. Wing feathers have appeared in the shape of needlelike structure of size 1 cm to 2 cm. Filoplumes on lateral and ventral tracts are replaced by needle like body feathers of 0.2 mm to 1 mm. Tail feathers have made their appearance in the form of needle-like structure of about 6 mm. length. Gape is yellow, legs are greyish pink (Plate XX, figs 51 and 52).

Fourteen-days old young

Body is almost covered by feathers, the head is dull black. Beak is yellowish, tip of the beak is light. Colour of legs is brownish yellow.

Plumage is generally on the adult pattern. Ventral plumage light brown in colour. The length of the wing feathers is 4.5 to 6 cm. Tail feathers are of 3 cm (Plate XXI, figs. 53 and 54).

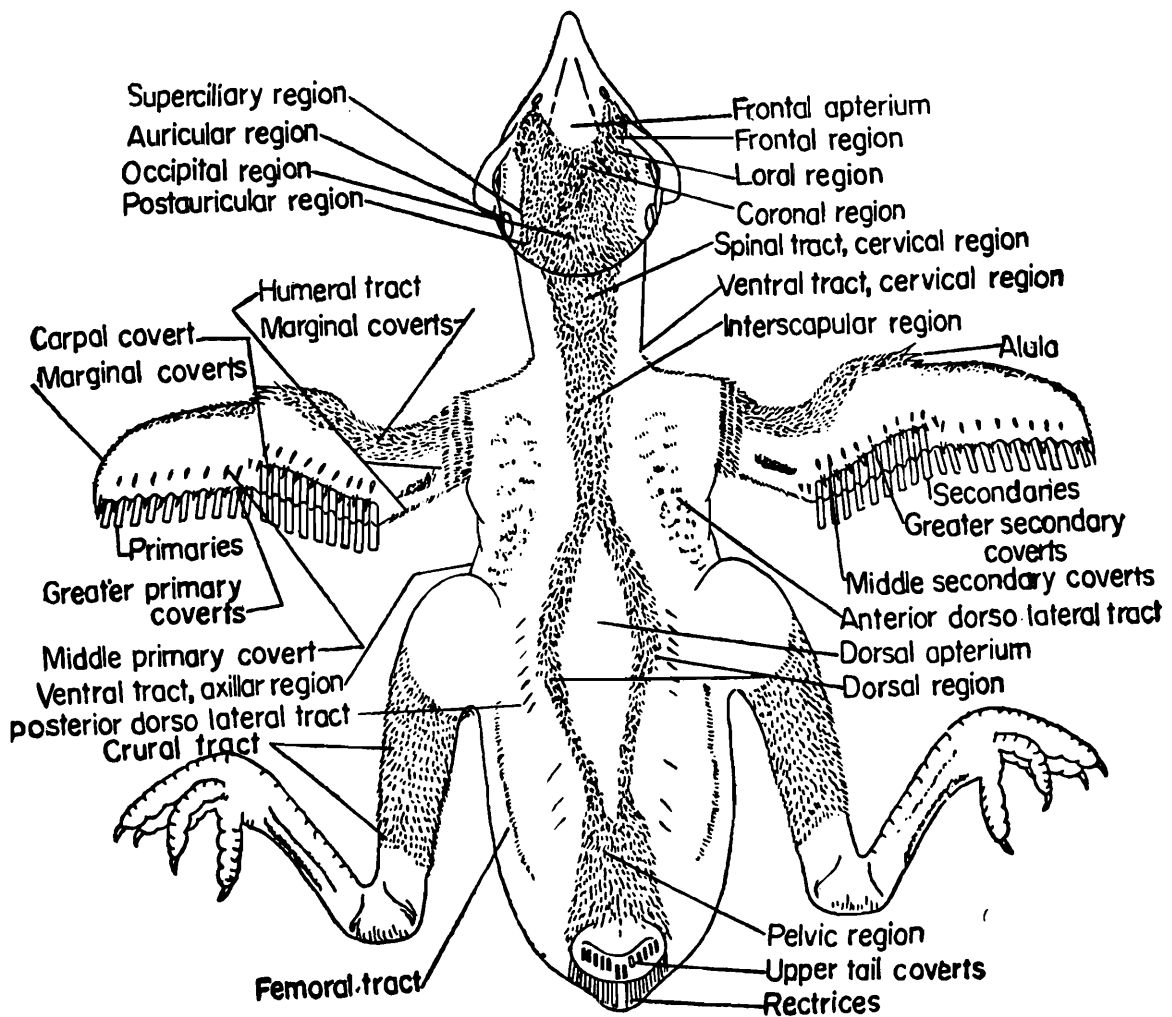


Fig. 13

Seventeen-days old young

The young is fully developed like the adult bird. Size of the tail feathers is shorter than those of the adult bird. Colour of plumage is less bright than that of adult. The rest of the physical features resemble those of the adult bird (Plate XXII, 55 and 56).

Behaviour of nestlings

For the first five days the eyes of the nestlings remain closed. Up to this age if a soft noise is made at the nest hole, the nestlings raise their necks and gape for food. Food demand continues even after the opening of the eyes. Eyes open from the 6th to the 8th day. After the 2nd day of opening of the eyes the fear complex develops. The nestling at this age, is able to distinguish between the arrival of a parent and that of an intruder. By this time they also start responding

to the alarm calls of the parents. On hearing an alarm call by one of the parents the young hastily withdraw inside the nest hole. Two-week old young ones come out the nest hole on the approach of an intruder. They may move higher up in the branches in the same tree or fly to a nearby tree to escape capture. If incapable of flying to

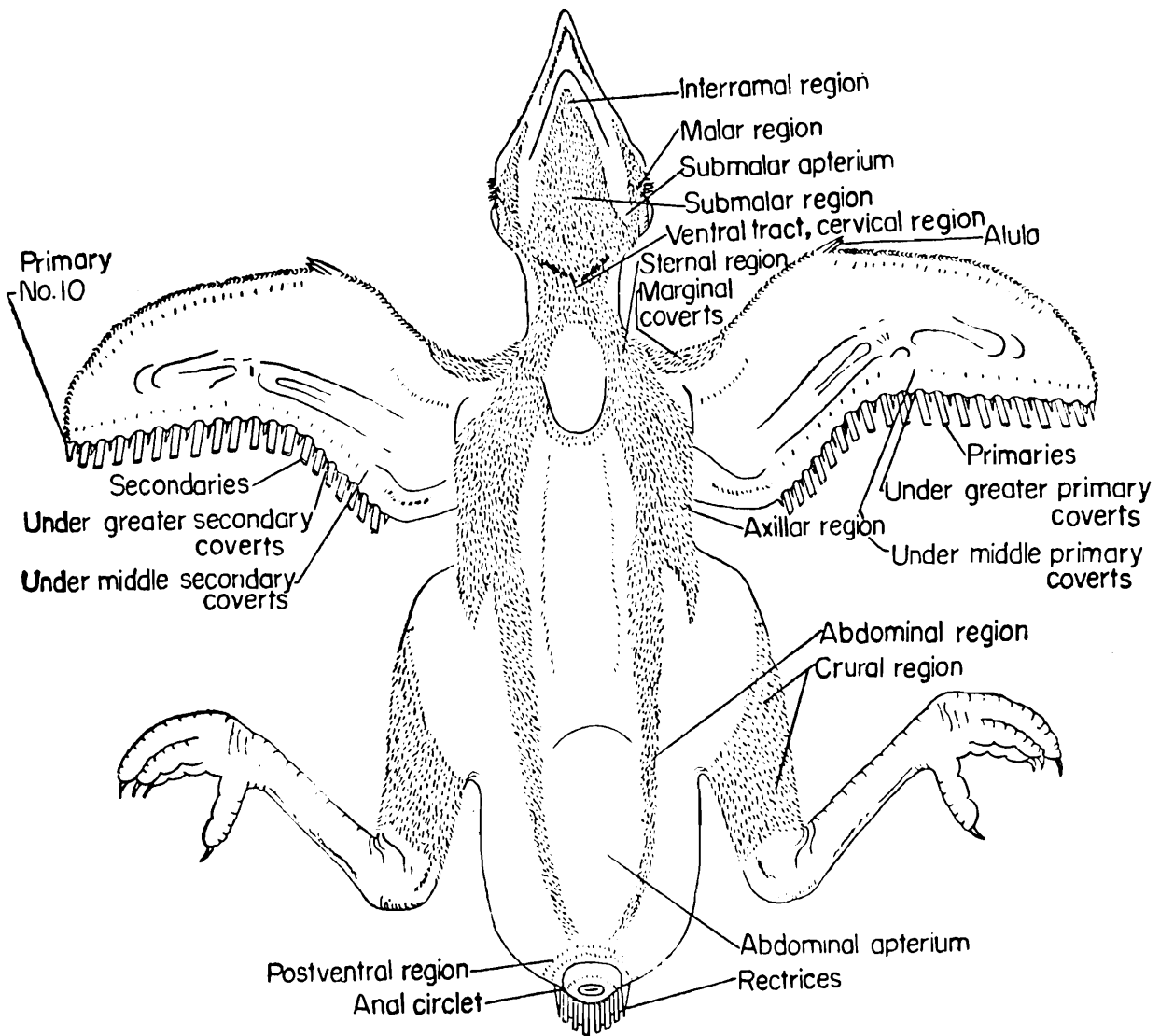


Fig. 14

another tree they drop to the ground and try to escape in the bushes or other vegetation on the ground. The parent-offspring recognition seems to be audiovisual. On a number of occasions when the young ones escaped into nearby bushes the parents were able to locate and feed them. On one occasion the hidden young one was observed to come out of the bush and approach the parent in response to the parents call.

At the age of 18-21 days when they leave the nest, the young ones join their parents on feeding trips within their territory. The parents lead them to food and demonstrate how to pick it. For the first two or three days the parents feed their young as they cannot pick enough food. Gradually they learn the technique of picking up the food. This

association lasts for 7-10 days, after which they part company to lead an independent life.

Length of the nestling period

On attaining the age of about 3 weeks the young leave the nest. The young that hatch out first are healthier than those that hatch out later and may leave the nest earlier. But they keep to the vicinity of the nest and are fed by the parents till they learn to pick up food independently (Table 45).

TABLE 45. *Length of the nestling period*

Nest No.	Last chick hatched on	Last chick left on	Period in days
1/76	4.6.76	23.6.76	19
2/76	7.6.76	28.6.76	21
7/76	9.6.76	29.6.76	20
3/77	8.6.77	28.6.77	20
15/77	14.6.77	2.7.77	18
19/77	18.6.77	9.7.77	21
4/78	16.5.78	5.6.78	20
12/78	16.5.78	3.6.78	18
15/78	30.5.78	19.6.78	20
16/78	12.6.78	30.6.78	18
1/79	13.5.79	2.6.79	20
6/79	12.5.79	31.5.79	19
8/79	27.5.79	15.6.79	19
9/79	5.6.79	25.6.79	20
Average			19.5

Nestling mortality

Quite a few of the young Brahminy Mynas that hatch out do not live to leave the nests. During the course of this study, out of 312 nestlings that hatched out in 82 nests, as many as 102 died in the nest. The mortality, therefore, works out roughly as 32.6% (Table 46).

TABLE 46. *Nestling mortality*

Year	No. of nest observed	No. of eggs hatched	No. of fledglings that flew out of the nest	No. of fledglings that died	Percentage
1976	11	41	28	13	31.7%
1977	20	78	51	27	34.6%
1978	24	92	61	31	33.6%
1979	27	101	70	31	30.6%
	82	312	210	102	32.6%

A majority of deaths occurred in the first week, presumably due to shortage of food. Other causes of mortality observed were human interference, predation by predators, accidental falls while practising flying, and natural calamities. A few deaths due to diseases also cannot be ruled out.

Nesting success

Nesting success depends upon a number of factors, the most important being the fertility of eggs, amount of food available at nesting stage, predation and interference by human beings.

In the present study a total of 336 eggs were laid in 82 nests. A total of 312 eggs hatched and 210 young left the nest. The nesting success, therefore, comes to 67.3% (Table 47).

TABLE 47. *Nesting success*

Year	No. of nest observed	No. of eggs hatched	No. fledglings that flew out of the nest	Percentage
1976	11	41	28	68.29%
1977	20	78	51	65.38%
1978	24	92	61	66.3%
1979	27	101	70	69.3%
	82	312	210	67.3%

Second Brood

Raising of the second brood is a common phenomenon with the Brahminy Myna. After the departure of the first brood the nesting pair maintain their territory and keep the possession of nest hole. The courtship routine is performed once more. About a week after the departure of the first brood repairs of the nest start which may take about 4-6 days time. A second peak of copulation is gained during this period. Three or four eggs are laid. Most eggs of the second brood were seen from later half of June to first week of July (Table 48). In cases where the clutch of the first brood was destroyed or all the hatchlings of the first brood died the raising of the 2nd brood was earlier than in the cases where the first brood was raised successfully.

TABLE 48. *The dates of laying of eggs*

Nest No.	1st egg laid on	2nd egg laid on	3rd egg laid on	4th egg laid on
17/76	17.6.76	18.6.76	19.6.76	20.6.76
18/76	8.7.76	9.7.76	10.7.76	—
20/76	11.7.76	12.7.76	13.7.76	14.7.76
24/77	27.6.77	28.6.77	29.6.77	—
25/77	7.7.77	8.7.77	9.7.77	10.7.77
20/78	12.7.78	13.7.78	14.7.78	—
22/79	18.6.79	19.6.79	20.6.79	21.6.79
24/79	25.6.79	26.6.79	27.6.79	—

The incubation period and the nestling period for the second brood remain the same as in the first (Table 49).

TABLE 49. *The incubation period and hatching pattern*

Nest No.	Egg No.	Laid on	Hatched on	Period in days
17/76	1	17.6.76	1.7.76	14 days
	2	18.6.76	1.7.76	13 days
	3	19.6.76	2.7.76	13 days
	4	20.6.76	2.7.76	12 days
18/76	1	8.7.76	21.7.76	13 days
	2	9.7.76	21.7.76	12 days
	3	10.7.76	22.7.76	12 days
20/76	1	11.7.76	24.7.76	13 days
	2	12.7.76	25.7.76	13 days
	3	13.7.76	25.7.76	12 days
	4	14.7.76	26.7.76	12 days
24/77	1	27.6.77	10.7.77	13 days
	2	28.6.77	10.7.77	12 days
	3	29.6.77	11.7.77	12 days
25/77	1	7.7.77	did not hatch	—
	2	8.7.77	21.7.77	13 days
	3	9.7.77	21.7.77	12 days
	4	10.7.77	22.7.77	12 days
20/78	1	12.7.78	25.7.78	13 days
	2	13.7.78	25.7.78	12 days
	3	14.7.78	26.7.78	12 days
22/79	1	18.6.79	damaged	—
	2	19.6.79	did not hatch	—
	3	20.6.79	2.7.79	12 days
	4	21.6.79	3.7.79	12 days
24/79	1	25.6.79	7.7.79	12 days
	2	26.6.79	8.7.79	12 days
	3	27.6.79	9.7.79	12 days

The rate of development of the young of the 2nd brood is almost same as of the first brood.

The second broods were raised by nearly 70% of pairs who raised the first brood. Seven pairs in 1976, 14 pairs in 1977, 16 pairs in 1978 and 19 pairs in 1979 raised the second brood successfully.

Out of eighteen pairs that were banded during the period of study (1976-79) thirteen pairs raised a second brood.

DISCUSSION

Breeding season

Duration

Most of the bird species do not breed throughout the year. Normally the individuals of a particular species in a particular area breed only during a particular span, or spans, of time in a year, during which they establish territories, select mates, copulate, construct nests, lay eggs, incubate and raise a brood or broods. This span (s) is (are) known to be the breeding season (s) for the particular species. The breeding season (s) for an individual species may be annual, biannual, perennial or irregular, depending upon the number of times in a year (or period of years) it goes through this schedule.

According to the current belief the commencement of the breeding season depends upon a number of factors, which involve natural instinct and physiological changes brought about by various ecological stimuli, mainly temperature rainfall, precipitation, quantum of sunshine, availability of food, changing conditions of habitat, etc, which are often responsible for bringing about the physical changes also. The length of the breeding season for a particular species depends upon

- (a) time required for :
 - (i) Occupation of territory
 - (ii) Pair formation
 - (iii) Nest construction
 - (iv) Laying
 - (v) Incubation
 - (vi) Nestling period
- (b) The time lag between the desertion of a nest and renesting and
- (c) The number of broods raised during the season.

During the course of this study it was observed that at Dehra Dun the Indian Pied Myna, *Sturnus contra contra* Linnaeus, has a single annual breeding season of about 6 months i. e. from late February to August. Ali and Ripley (1972 : 172-174) and Usha Ganguli (1975 : 207) also described only one breeding season for this species i. e. from March to September for the whole country and May to July for Delhi respectively. It was observed that in the years of prolonged winter rains the commencement of breeding season at Dehra Dun may be delayed upto March or even April. The extension of the winter rains also retards the commencement of breeding activity in this species. It will, however, not be wise to attribute the delay in the commencement of breeding season to any one climatological factors alone as a complex of such factors is involved in the initiation of the breeding season.

In the case of Brahminy Myna, *Sturnus pagodarum* (Gmelin), too, it has been observed during the present study that this species also has a single annual breeding season of about six months from March to August. Ali and Ripley (1972 : 161) gives the breeding season for the whole of India as 'Overall February/March to August/September, the principal periods varying with locality ; earlier in South India, later in the North, equivocal in Ceylon (Sri Lanka) : believed to be July-August'. Ganguli (1975 : 205) described that pair formation takes place in March and nesting from April to July in Delhi. The single annual breeding season in both the species is in conformity with the breeding pattern of other species of the family which have been studied in detail for example in the case of Common Myna, *Acridotheres tristis tristis* (Linnaeus). Ali and Ripley 1972 : 179) mentions the breeding season of *Acridotheres tristis tristis* as 'overall March to September, principally April to July, but peak periods varying locally. In Kerala chiefly March-April, commencing as early as mid January' Lamba (1963 : 11) also wrote about a single breeding season of this species in South India. During the present study not much attention was paid to *Acridotheres tristis* on account of a lot of work having been already done on the subject by the foregoing authors. It was, however, noticed that one nest box was occupied by a pair of Common Myna in middle of October 1975. The pair started the nest construction and continued for two three days. They left the box and did not come for 20-25 days, again they came the nest box and constructed the nest for another two to three days. Then they disappeared for more than one month. After that in the last week of December they came to the nest box, made regular visits but did not construct further. In January and February they constructed irregularly for two to three days. Ultimately they occupied the nest and by March 20th laid a full clutch. From the above

account it would appear that some of the climatological factors/conditions that induce breeding in *Acridotheres* are repeated in October-November. This phenomenon has already been recorded for *Corvus splendens* by Lamba (1977 : 399-408). However, a similar occurrence was not noticed in the case of species studied at Dehra Dun.

Initiation factors

It is not an easy task to offer a definite explanation of the dissimilarity between the initiation and length of the breeding season of Mynas at Dehra Dun and elsewhere in India, as the ecological and physiological data for other areas are not available for comparison. But it can certainly be presumed that breeding is initiated by the operation of one or more factors mentioned earlier. Different workers throughout the world have experienced that these climatological factors affect different species in a different manner in the same or different areas. For example Nice (1937) and Kluijver (1951) have correlated the rising temperature to egg-laying in some temperate zone species, but in Central America quite a few species breed when the temperatures are falling (Van Tyne and Berger, 1959 : 314). Similarly, the enlargement of gonads (hence breeding) has been attributed to the increasing length of the day at higher latitudes but Hummingbirds in the Western Highlands of Guatemala commence nesting when the days start becoming shorter (Skutch, 1950). Four species of albatrosses and six species of smaller petrels in New Zealand show the same behaviour (Richdale, 1952 : 67), Moreau (1950) and Keast and Marshall (1952) often found the rainfall as the stimulus for reproduction in the desert areas of Africa and Australia. Whereas Skutch (1950) observed that a majority of birds breeding at the height of the dry season in western Guatemala. Skutch's (1950 : 212) conclusion about his studies on Central American birds seems to be most logical. He writes 'if any single astronomic or climatic cycle tends directly to stimulate the reproductive activities of birds, its action is so weak that any species which finds conditions peculiarly favourable for reproduction at some divergent season of the year may escape its control'. At Dehra Dun the breeding season of Pied Myna commences by late February and that of the Brahminy Myna by early March when the temperature is rising, quantum of light is increasing, humidity is decreasing and the winter rains are coming to an end. Prolongation of the winter rains appear to have a pronounced delaying effect on the commencement of the breeding season of Indian Pied Myna, but hardly has any effect on the Brahminy Myna.

However, the initiation and length of the breeding season of mynas was observed to depend more on the availability of food rather than

on any other single factor. The breeding season of Brahminy Myna at Dehra Dun coincides with the fruiting of *Lantana* and *Ficus* species, a favourite food of the species. Hatchlings of both the species emerge just as the rains start, ushering a boon in insect life, the main food of nestlings. Similar observations to these have been made by other workers elsewhere on a number of other bird species (Skutch, 1950 : 216-222 ; Moreau, 1950 : 262-265 ; Thomson, 1950 : 180-184 ; Bertram, et. al. 1934 : 819-823 ; Marshall, 1952 : 326-333 and Lamba, 1965 : 425-433).

Pair formation

Duration of bond

In most of the avian species the individuals of the opposite sexes pair up for one breeding season only, as revealed by extensive studies of some ornithologists, such as Heinroth (1928), Lack (1940) and Lamba (1963-1979) etc. The two sexes stay together for a part or whole of the breeding season, according to their accepted share of domestic responsibilities.

Both the species of Mynas i. e. Indian Pied Myna and Brahminy Myna studied at Dehra Dun were observed to pair only for the duration of the breeding season. In the non-breeding season no distinct pairs were met with. In fact after the breeding season the pairs or rather families re-integrated into small flocks and remained thus till the start of the next breeding season.

In the case of Common Myna Lamba (1963 : 11) has suggested a possibility of pair formation throughout the life. Usha Ganguli (1975 : 208) wrote that 'pairing up in this species seems to be throughout the year'. Pairing for life has also been hinted out in the case of Black Crow, *Corvus capensis* (Skead, 1952 : 43+), Rook (Yeates, 1934 : 33) and a few other species (Baker, 1935 : 472 ; Lack, 1940 : 271 ; Robinson, 1949 : 106) but no definite conclusion of their doing so can be furnished, except in the case of Swan (Heinroth, 1912).

To study the duration of bond, both the males and females of two pairs of each species were banded in 1978, in the case of Indian Pied Myna these banded birds paired up with different birds in 1979 and in the case of Brahminy Myna one pair could not be studied next year. The male and female of the second pair, paired up with different birds in 1979. It will be rather naive to come to a definite conclusion on the basis of a study of two pairs only.

Recognition of mate

It is supposed that birds recognise their own species through their association with their parents (imprinting) and their opposite sex through courtship behaviour or sexual recognition signs. The behaviour of hand-raised birds, who from the nestling stage treat their human keepers as parents, strongly indicates that the recognition of own species in birds occurs through association (imprinting) with parents at the nestling stages. Nice (1943 : 192) wrote about the subject saying that 'Some of Lorenz's Jackdaw treated him as their wife, others as their husband. A male Eagle Owl courted Dr. Heinroth his sister courted Frau Heinroth. A male Corncrake and female European Partridge both courted Frau Heinroth while a male pheasant courted Dr. Heinroth, and the south American Bittern (*Tigrisoma*) at the Amsterdam Zoological Garden, would, with its ceremony of nest relief, invite Portielje (1922) to step into its nest and incubate'. It may therefore be assumed that the Mynas recognise their own species by their association with the parents i. e. imprinting during the nestling period.

In the case of Indian Pied Myna both sexes exhibits distinct courtship display. The male puffs up its feather and bobs its head up and down a couple of times. The female crouches down low spreading one of its wing fully, the head held at an angle and the wing tip almost touching the ground, the feathers of the crown are slightly raised and the tail fanned out a bit. In the case of the Brahminy Myna however only the male indulges in display. The displaying male starts singing and stands erect on the grass, puffs up his plumage, throws the head back, raises the black crest, expands the tail and lowers it to the ground. It is presumed that the opposite sexes in both these cases recognise each other by their respective display (or the lack of it).

Lack (1953-64) has applied Darwin's verdict that 'The females are more excited by or prefer pairing with, the more ornamental males, or those which are the best songsters, or play the best antics'. It could not however, be studied beyond reasonable doubt to be the case in the two species of Mynas which are unimorphic and lack melodious songs (of course by human standards). Perhaps it is the combination of song and display which attract the female to a male.

These three species of Mynas, *Sturnus contra contra* Linnaeus, *Sturnus pagodarum* (Gmelin) and *Acridotheres tristis tristis* (Linnaeus) recognise their mates by visual as well as auditory cues at the nesting stage. The partner incubating or guarding the nest would leave the nest only when its mate alighted on the nesting tree or near the nest, or when it gave

an alarm call. Similar action by other individuals of the neighbourhood fails to induce a similar response except in cases of community alarm calls when all incubating individuals tend to join in the community defence.

This behaviour of these mynas is in accordance with mate recognition of many other species, such as Jackdaws (Lorenz, 1935), Swans (Heinroth, 1912), Flicker (Noble 1936) Song Sparrow (Nice, 1943) and Gulls (Kirkman 1937, Goethe, 1937, Tinbergen, 1936b), who recognise their mates by face (Swan and Flicker), features of the head (Jackdaws) and voice or song (Song Sparrow, Gulls).

Stability of Bond

The pairs once formed, are always permanent for a single breeding season in the case of Indian Pied Myna and Brahminy Myna. But in the case Common Myna, most probably they are found in pairs throughout the year. Chances of acquiring a new mate are rare and normally possible only in the event of death of one partner. The partners are faithful and considerate. Both bear the responsibilities of various domestic duties. The male Brahminy Myna sometimes provides the food to the incubating female. No attempts are ever made for any extramarital sexual union by any one of the pair. The Mynas are monogamous in the strict sense of the word.

This type of behaviour has been noticed in many other passerine species by different workers. To cite a few are Song Sparrows (Nice, 1943) Myna (Lamba, 1963 : Sengupta, 1968), Rook (Yeates, 1934), Crows (Lamba 1963 and 1966), Black Drongo (Lamba, 1963), Indian Roller (Lamba, 1963). The Indian Hoopoe, (Lamba, 1965), The Roseringed Parakeet (Lamba, 1966), Indian Sunbirds (Lamba, 1968, 1978).

Copulation

The copulation in most birds takes place after the pair formation, and is most frequent during the nest construction and lasts upto the egg laying stage. The copulation may stop with the laying of the first eggs in some species (Allen and Nice, 1952 : 621), while in others it is continued even after the incubation has started (Summers Smith, 1955 ; Berger, 1957 ; Lamba, 1963, 1965b, 1977) or even after the eggs hatch (Van Tyne and Berger, 1959 : 272 ; Lamba, 1963 f). The copulation in both the species of Mynas starts immediately after a successful courtship display and affects the pair bond. The frequency of copulation is highest during the nest building stages in these species of Mynas. It gradually goes down during the laying period and is seldom encountered when the eggs are being hatched.

The copulation in Mynas occurs in normal bird fashion and has also been so observed by Varghese (1935 : 186) and Jamal Ara (1954 : 940), Lamba (1963 : 12), Sengupta (1968), and Usha Ganguli (1975 : 205).

The copulation in both the species of Mynas like most other birds, takes place on ground, in trees, on tops and ledges of buildings and in the nests. In some species of birds copulation is known to take place only in the nest as in Rooks (Yeates, 1934). The copulation at the nest alone can be correlated with colonial nesting. Most of the colonial birds are known to copulate at the nest. Although both the species of Mynas exhibit colonial nesting yet copulation in these species is not restricted to nests alone.

TERRITORY

During the course of the present study it was observed that in the case of Indian Pied Myna, *Sturnus contra contra* Linnaeus,

- (a) the territory is claimed early in the breeding season by the male,
- (b) the occupation of the territory is announced by the mere presence of the male, as no distinctive song was heard,
- (c) courtship and copulation usually take place inside the territory,
- (d) most of the food for self and young is obtained from the territory and the areas close to the territory,
- (e) the defence of the territory is made by the male prior to the pair formation and by both sexes after the pair formation by warning call, threat display and actual combat. Occasionally a social defence system is also observed when confronted by a large or dangerous predator like a hawk or a snake,
- (f) the occupation and defence of the territory is during the breeding season only,
- (g) the territorial limits (area of defence) differ according to the type of intruder.

It reveals therefore, that in the territorial habits the Indian Pied Myna, *Sturnus contra contra* Linnaeus :

- (A) exhibits a mixture of type (1) and (iii) of Hinde's (1956 : 342) classification,
- (B) the territory is occupied and defended before the pair formation,
- (C) the territory is defended mainly for pair formation, nesting site, nest, eggs and brood.

In the case of Brahminy Myna, *Sturnus pagodarum* (Gmelin) it was observed that

- (a) the territory is claimed by the male before the pair formation,
- (b) the announcement of the occupation of territory is made by a warbling song,
- (c) the nesting hole is selected within the territory with the mutual consent of both the partners,
- (d) courtship and copulation take place within the territory,
- (e) the collection of the nesting material is done within the territory,
- (f) the food collection may be done out of the territory,
- (g) the territory is defended by both sexes by a warning note, pursuit and attack,
- (h) the territory is occupied and defended only for the duration of the breeding season, and
- (i) the size of the defended area depends upon the type of intruders.

It follows therefore, that the Brahminy Myna,

Sturnus pagodarum (Gmelin)

- (A) can be placed in type (iii) of Hinde's (1956 : 342) classification,
- (B) occupation of the territory is before the pair formation,
- (C) defends it mainly for pair formation, nesting site, nest, clutch and brood,

These observations compare well with these already known in the case of Common Myna, *Acridotheres tristis tristis* (Linnaeus) (Lamba, 1963b, and Sengupta, 1968)

- (a) the territory is claimed after the pair formation and may change from year to year,
- (b) the occupation of the territory is announced by an amazing gamut of keek-keek-keek, kok-kok-kok, Churr-Churr etc. made by the male,
- (c) courtship and copulation usually take place inside the territory,
- (d) most of the food for self and young is obtained from the territory and the areas close to the territory,
- (e) defence of the territory is made by both the sexes by warning call and actual combat, a social defence system is present, all nesting pairs of the locality also join in defence efforts of a threatened pair against intruder,

- (f) the occupation of the territory is during the breeding season only,
- (g) the territorial limits (area of defence) differ according to the type of intruder,

It reveals therefore, that the Common Myna, *Acridotheres tristis tristis* (Linnaeus) :

- (A) can be placed in type (iii) of Hinde's (1956 : 342) classification,
- (B) occupies the territory and defends it often before and sometimes after the pair formation,
- (C) defends it mainly for nesting site, nest, eggs and brood.

Function of the territory

Quite a number of theories has been put forward regarding the function of the territory, a few important ones are as follows :

1. to conserve food for the young (Altum, 1868 ; Howard, 1920),
2. to prevent undue increase of the species (Moffat, 1903),
3. to prevent interference in family life (Nice, 1933d ; Mayr 1935) and
4. to bring the pair together (Lack, 1935 ; Noble, 1939 ; Tinbergen, 1939).

From the present studies of Mynas it can be concluded that the main functions of the territory in *Sturnus contra contra* Linnaeus and *Sturnus pagodarum* (Gmelin) are to ensure protection to nest, egg and young, that is, the functions proposed by Nice (1933d), Mayr (1935), Lack (1935), Noble (1939), Tinbergen (1939) and Lamba (1977).

Defence of territory

Before the pair formation the male in both the species defends its territory. After the pair formation the female too lend a hand in the defence. Normally intruder vacates on the show of force. Occasionally a fight may occur for the possession of a nest hole between different hole breeding species, like Green Barbet, Magpie Robin and House sparrow.

Such a fight between Green Barbet and Brahminy Myna have also been observed on two occasions by M. MacDonald (1960 : 92-99). In one case Brahminy Myna captured the hole very smoothly from Green Barbet. In another case the fight for possession lasted for a week with the Brahminy Myna emerging as the victor. No such fight with Green Barbet was observed during this study although Green Barbets are quite common in the study area. The only fight that occurred for

the possession of a nest hole took place between the Brahminy Myna and the House Sparrows. In one case the nesting hole was already occupied by a pair of House Sparrow when a pair of Brahminy Mynas gate-crashed and pushed the sparrows out. The displaced House sparrow left the hole quietly and perched nearby. The usurping pair (of Brahminy Mynas) cleaned out the nesting material gathered by the house sparrow and started their own construction. But whenever the pair of the Brahminy Myna left the hole probably for feeding, the house sparrow reoccupied it and even started construction. On the arrival of the Brahminy Mynas the pair of house sparrows surrendered and left. This tussle continued for five days. On the sixth day five neighbouring pairs of house sparrows joined in the melee and were successful in driving away the pair of Brahminy Myna. Ultimately the pair of House Sparrows won their claim.

Nest

Nesting sites

The present studies revealed that a nesting site is usually selected by the male at the time of occupation of the territory. The site is shown to the bride to be. She usually cohabits and stays on if she accepts the nesting site. Or she may allow the male (owner of the territory) to perform sexual intercourse, but may change her mind about the suitability of the nesting site. In such cases both the sexes of these species of mynas together start searching for a suitable nesting site. A lot of hesitation is exhibited while the selection of a nesting site is being made. Many possible sites are visited before a final decision is taken. Many a time a site selected is abandoned on account of its inability to hold the coming-up nest or frequent appearances of predators or intruders in the vicinity. It could not be concluded with certainty as to which sex makes the final selection. Apparently the female has the final say in the matter.

A thin, vertical multipronged fork, at the height of 5-15 metres branch is usually selected for construction of the nest by the Indian Pied Myna. Sometimes an electric pole is also used for the purpose.

In the case of Brahminy Myna hole in a tree trunk or a wall is usual site. During the course of study 42 nest boxes were nailed to trees and walls in a big compound. All of them except one were successfully occupied by this species. Colonial breeding in this species has also been reported by Ali and Ripley (1972 : 161). No such colonial nesting was observed during the course of this study.

In the case of Common Myna holes in cliffs (Baker 1926 : 54) in banks (Baker, 1933 : 525) in trees trunks, Hume (1889 : 377-380) walls of houses between the ceiling and roof (Ali and Ripley 1972 : 179-80) are used to place a nest in. Other sundry sites like old crow's nest have also been reported by various workers (Currie, 1916 ; Ticehurst, 1922, p. 623), a dense creeper (Bingham), on a railway signal (Aitken), occasionally cup-shaped or domed nests like those of a Pied Myna may also be constructed (Ali and Ripley, 1972 : 179-180). Occasional occupation of unusual sites, presumably under unusual circumstances, by a variety of Indian birds is a well known phenomenon recorded by a number of workers in the past (Holdsworth, 1872 ; Adam, 1873 ; Hume, 1889 ; Beetham, 1903 ; Currie, 1916b ; Bennett, 1918 ; Waite, 1920 ; Shuttleworth, 1921 ; Shipp, 1922 ; Inglis, 1922 ; Paster, 1926 ; Bates, 1926 ; Biddulph, 1937 ; MacCann, 1941 ; Kingdon Ward, 1949 ; Parsons, 1950 ; Inglis, 1951 ; Betts, 1954 ; George, 1957 ; to mention a few).

Yeats (1934) and Lamba (1963-1979) have opined that the many passerine birds return to the same nest site year after year. During the study of Mynas a number of nests were observed to be occupied every year by these species. It could not, however, be ascertained if the ownership remained constant or changed every year. No such unusual nesting sites were encountered in the case of Brahminy Myna. The only unusual nesting site (if they can be so called) were the telephone and electric poles made use of by the Pied Myna. But this again could be on account of nonavailability of normal and suitable nesting sites in trees on account of urbanisation. Such a phenomenon has been recently recorded for House Crows (Rudolf Altevogel and Davis 1979) in large metropolitan cities like Calcutta, Bombay etc.

Nesting materials

Generally courser materials like small twigs, pieces of stems of creepers, grass stems, straw feathers, paper pieces, pieces of cloth, snakes skins, wrappers of cigarettes, cellophane paper etc are normally used in the construction of the outer lining of the nest in all these species of mynas.

The nest cavity or egg chamber is lined normally by comparatively softer materials like fine stems and leaves of grass, hairs, cotton etc.

Like some other species (Lamba, 1963 : 4 ; Sengupta, 1965) the mynas add additional material to the nest after its completion.

Nest building

In both these species of mynas the construction of the nest is done mostly by the female of the pair. The material is however collected by both sexes. The share of the male Indian Pied Myna in actual construction was observed to be about 25%, whereas that of the male Brahminy Myna hardly 10%. Ryves (1944) had suggested four major categories of birds based on the role of sexes in the construction of the nest. Van Tyne and Berger (1959 : 276) added another three to the list bringing the total to the following seven.

1. Both sexes build the nest (a) the male and the female share more or less equally. (b) the male builds dummy or cock nest.
2. The female builds but only the male provides the materials.
3. The female builds without the help of the male.
4. The female builds but both sexes gather the materials.
5. The male builds but the female provides the materials
6. The male alone builds the nest.
7. No nest is built.

As may be seen, neither category 1 nor category 4 precisely covers the situation met with in the case of the Indian Pied Myna. It falls generally under category 1. As the share of sexes is unequal, the female doing the major portion of the construction, Lamba (1977), too, found a similar situation in Indian Crows and has suggested that one more subcategory under category 1 should be recognised, that is, c. The share of the female is more than that of the male.

Brahminy Myna falls generally very close to the category 4, but with a slight variation as a small amount of construction work is done by the male also.

It normally takes 11 to 22 days for a pair of Indian Pied Myna and 12 to 25 days for a pair of Brahminy Myna to complete the construction of the nest with lining and all else. The pairs which start building early in the breeding season take comparatively more time to finish the nest than the ones who start late in the season. Considering the size of the nest and the amount of material which has to be collected for it, the mynas are rather fast workers. Small to medium size passerines are known to finish a nest in 3 to 10 days, for example *Pycnonotus cafer* 3 days (Dixit, 1963) ; Prothonotary Warbler, 3.3. days (Walkinshaw, 1941) ; *Myioborus miniatus auranticus* 3-5 days (Skutch, 1945) ; Cader Waxwing, 5-6 days (Putnam, 1949) ; *Nectarinia asiatica* 6.8 days (Bates, 1931, Dass, 1964) ; *Dicurus macrocercus*, 5-10 days (Lamba, 1963b) ;

Acridotheres tristis 6-8 days (Sengupta 1965) ; 5-12 days (Lamba, 1963c) ; 7 days (minimum time observed) is, therefore, quite a creditable period in which to finish such a large sized nest by Indian Pied Myna.

Eggs

Laying pattern

The laying pattern appears to be the same in both the species. All the two species of Myna i. e. Indian Pied Myna, Brahminy Myna (and also the Common Myna) lay one egg a day, at regular intervals of about 24 hours, usually in the morning between 5.30 to 10 hours till the clutch is complete. The normal egg laying habit of mynas compares well with some of the other Indian passerines whose time and mode of laying has been studied by Ambedkar, 1964 ; Lamba 1963a, 1963b, 1965a, 1968 ; Sengupta, 1968.

Clutch size

A good deal of variation was observed in the clutch-size of these Mynas during these studies. It was observed that the Indian Pied Myna lays from 3 to 6 eggs. The average annual clutch size varied from 3.8 to 3.9. Similarly the Brahminy Myna also lays from 3 to 5 eggs. The average annual clutchsize varied from 3.8 to 4.0. The common myna generally lays 4-5 eggs but occasionally 3 and 6 are also laid.

The variation in clutch size as noticed in these species of mynas at Dehra Dun is true of most avian species all over the world, though a few species invariably lay the same number. Geographical variations in clutch-size have been reported in several Central American (Skutch, 1949, 1953), African (Moreau, 1944) and European (Lack, 1947-1948) birds. Annual fluctuation in the average clutch-size on account of scarcity or abundance of food (Elton, 1942) and scanty or ample rainfall (Lack, 1947-48), (Gilbert, 1936) has also been recorded.

Variation in clutch-size has been correlated with physical energy by R. K. Murton and N. J. Westwood (1977) in their book 'Avian breeding cycles'.

The regulation of clutch size in birds has been attributed to a number of environmental, physiological and individual factors, such as :-

1. *Covering or brooding capacity*

The number of eggs laid depends upon the coverage by the birds brood patch.

2. *Danger or Mortality*

The size of clutch varies with the amount of danger to which the bird is exposed (Fox, 1899, cited by Romanoff and Romanoff, 1949 : 67), or with the mortality rate of the species.

3. *Availability of food*

Abundance of food in the breeding area induces the bird to lay larger clutches (Schneider, 1928 ; Elton, 1942 ; Moreau, 1944). Even the quality of food available sometimes effects the clutch-size (Kluijver, 1933).

4. *Physiological capacity*

Physiological capacity of a bird limits the number of eggs laid by it. Even the age of bird is known to effect the clutch-size. Thus, the first year birds lay smaller clutches than the older individuals (Ruiter, 1941 ; Kluijver 1933 ; Wissel, 1927). Very old birds also tend to have smaller clutches (Jourdain, 1925). Sometimes, an individual bird which lays an unusually large or unusually small clutch on one occasion tends to do the same on other occasion too (Lack, 1947-1948).

5. *Feeding capacity*

Clutch-size for most birds represents the largest number of young that the parents can feed (Lack, 1954).

On the basis of these studies, it is very difficult to make out any one of the above-mentioned factors as solely responsible for the determination of clutch size in the mynas in our study area. Perhaps more than one of these factors are involved.

Colour of the eggs

Generally the colour (and even markings) of various clutches of the same species is known to vary from clutch to clutch (Ali and Ripley 1972). But the colour of the eggs vary slightly in various clutches of both these species of Mynas i.e. Indian Pied Myna and Brahminy Myna.

The colour of the egg of both the species of Mynas is blue, those of *Sturnus pagodarum* (Gmelin) being slightly paler than those of *Sturnus contra contra* Linnaeus which are slightly darker than those of the *Sturnus pagodarum* (Gmelin). The shell is without any markings and fairly glossy in both the species.

Size of the eggs

Like the colour, the size of eggs in birds is also known to vary not only from clutch to clutch but also egg to egg of the same clutch (Ali and Ripley 1972, Van Tyne and Berger 1969). In both the species of Mynas studied the size of the eggs very considerably not only in the eggs of various clutches but also in the various eggs of the same clutch.

In the case of Indian Pied Myna 176 eggs were measured for the average size which was found 27.41×20.32 mm. This compared favourably with Baker's (1933) average 27.6×20.2 mm for 100 eggs.

The size of 103 eggs of Brahminy Myna, measured on an average 24.5×19.0 mm. This compared favourably with Baker's (1933) average 24.6×19.0 mm for 100 eggs.

Weight

The variation in the weight of eggs too, like colour and size, occurs greatly in the eggs of various clutches and even eggs of the same clutch of all avian species (Van Tyne and Berger 1959, Ali and Ripley 1972). The weight of eggs of *Sturnus contra contra* Linnaeus was found from 4.974 grams to 6.391 gms. (Average 5.627 grams of 318 eggs) and that of Brahminy Myna from 4.315 grams to 5.906 grams. (Average 5.039 grams of 118 eggs).

The average maximum and minimum weights per clutch were found to be 6.07 and 5.061 grams respectively for *Sturnus contra contra* Linnaeus and for *Sturnus pagodarum* (Gmelin) it was 5.844 and 4.429 gms respectively. The reasons for the variation in size and weight have already been discussed in the foregoing pages.

Incubation

Commencement

The Indian Pied Myna starts sitting on the eggs during the night with the laying of the first egg. It is doubtful if she applies any heat during the first one or two nights because some birds have been known to sit on eggs without applying heat to them (Van Tyne and Berger 1959 : 293). The hatching pattern indicates that the regular incubation does not start till the second or the third egg is laid. It was observed that the first two hatchings are out on the same day within six hours of each other. In the case of Brahminy Myna the female starts sitting on the eggs in the daytime after the laying of the second egg. As evident from the hatching pattern she apparently starts incubation only with the laying of the second egg.

Share of sexes

In a large variety of birds both sexes takes part in the incubation. In most such cases the share of female is always greater than that of the male. There are many exceptions to this rule. In galliformes it is the female alone that incubates. In certain polyandrous species like the Painted Snipe it is the male alone that incubates the clutch, the female departs after having laid the clutch to mate with another available male. In many shore nesting birds (Waders) the incubation is left entirely to the atmospheric heat. The Nicobar Magapode leaves the incubation to the heat generated by the decaying vegetable matter, in a mound of which it lays its clutch and forgets.

In the case of *Sturnus contra contra* Linnaeus and *Sturnus pagodarum* (Gmelin) it was observed that the incubation, for the most part is done by the female. During the daytime, the male relieves the female occasionally, but the female alone incubates during the night. Skutch (1957) has suggested that incubation by both sexes was the primitive method among the birds. The share of the male Brahminy Myna in incubation is lesser than that of the male Indian Pied Myna. It, therefore, follows that as far as incubation is concerned *Sturnus contra contra* follows a primitive pattern as compared to *Sturnus pagodarum*.

Period of incubation

Nice's (1954) method of determining the incubation period has been followed i. e. the incubation period has been calculated from the laying of the last egg to the hatching of the same. This method has an advantage over all others. The birds may not start incubating with the laying of the first, second or even third egg. A number of birds are known to start incubating only after the clutch is complete.

The incubation period of *Sturnus contra contra* Linnaeus was found to be 14-15 days during the present study and that of *Sturnus pagodarum* (Gmelin) was found to be 12 days. This compares well with other species of Myna i. e. 13-14 days incubation period of the Common Myna, *Acridotheres tristis* (Lamba and Tyagi, 1975 and Sengupta, 1968).

The young

The young of both *Sturnus contra contra* Linnaeus and *Sturnus pagodarum* (Gmelin) hatch out one after the other at intervals of 4 to 24 hours, more or less in the order in which the eggs are laid. The first and the second eggs in *Sturnus contra contra* Linnaeus hatch on the same day at an interval of 6 hours and in *Sturnus pagodarum* the first and second egg may hatch in the manner of *Sturnus contra contra* or may

hatch after an interval of 24 hours. It has been suggested by some workers that this hatching of eggs over a period of several days, helps in protecting the clutch and brood from the danger of predations (Van Tyne and Berger, 1959 : 29+), but Lack (1947 : 325) feels that it is an adaptation 'to bring brood size and available food supply into correspondence' The hatching success of *Sturnus contra contra* and *Sturnus pagodarum* works out as 89% and 93.23% respectively.

The nestlings of all avian species can be divided into two main groups viz. nidicolous and nidifugous. The nidicolous nestlings emerge from the egg with their eyes closed and almost naked. They are incapable of movement at birth and have to be fed and protected by the parents. Most groups of birds have this type of nestling. The nidifugous nestlings on the other hand emerge with eyes open, covered with body feathers and are capable of movement (running) and independent feeding when led to food by parents. Gallinaceous birds, Waders and Water birds have this type of nestlings.

The nestling of both the species of Mynas i. e. Indian Pied Myna and Brahminy Myna are nidicolous. The colour of the gape of nestlings in both the species is yellow and probably serves the same purpose as the elaborate directive marks of the mouth cavities of some of the other species. The average daily gain in weight during the first 8 to 10 days in both *Sturnus contra contra* and *Sturnus pagodarum* is more or less their own weights as the time of hatching.

Although there is marked difference in weight of various nestlings of a brood on account of asynchronous hatching, it does not make any substantial difference in the general development of the body. In both the *Sturnus contra contra* and *Sturnus pagodarum*, the eyes open from 5th to 8th day, the feathers cut the skin on 4th, 5th day and fear complex develops after a day or two of the opening of the eyes. And, all the nestlings of a brood are more or less of similar weight at the time of leaving the nest.

Nestling period

The length of the nestling period of *Sturnus contra contra* is 21 to 27 days (average 23.5 days) and that of *Sturnus pagodarum* is 18 to 21 days (average 19.5 days). The nestling period in both the species is slightly more than $1\frac{1}{2}$ times the incubation period. There appears to be no set ratio between these two period in various avian species. The nestling period may be shorter, as long as, or even more than twice the incubation period, depending upon the species of birds (Skutch, 1945 : 34, Van Tyne and Berger, 1959 : 301).

Nesting success

Nesting success in birds usually depends upon a number of factors like the fertility of the eggs, the availability of food for nestlings, chance fall of the nestlings from the nest and interference by predators. In both the species i. e., Indian Pied Myna and Brahminy Myna the fertility rate in eggs is very high. The availability of food is an important factor in these mynas. Most of the young die owing to scarcity of food specially in the first week. Some deaths occur owing to the fall of the nest being blown away as a result of pre-monsoon thunderstorms. Some of the deaths may have occurred on account of diseases etc. also.

The average nesting success in Indian Pied Myna was found to be 55.4%. In 1978 when heavy monsoons occurred during August a large number of nestlings perished reducing the nesting success to mere 52%. On the other hand in 1977 when the conditions were the optimal the highest nesting success of 57.9% was recorded.

The nesting success in Brahminy Myna averaged 67.3% during the period of study. It ranged from 65.38% in 1977 to 69.3% in 1979. The severity of rains do not seem to effect this species, probably owing to the fact that its nests are located in holes and are sheltered from rains.

Second brood

Most birds do not raise more than one brood in a single breeding season. Some of the passerine are known to raise two or sometimes even three broods in a single breeding season in quick succession. Probably the optimum of the factors involving in inducing the breeding of these birds continues for a longer period and they have comparatively shorter incubational and nestling periods. The five species of mynas which are common in Dehra Dun usually raise more than one brood. Ali and Ripley (1972 : 174 ; 161 ; 179 ; 185) described two broods in Indian Pied Myna, two sometimes three, broods in Brahminy Myna and Common Myna and two broods in Jungle Myna. Baker (1926 : 62) also described three broods in Indian Pied Myna.

During the present study, however, only two broods were noticed being raised by Pied Myna. No case of third brood being raised was observed. Even the number of second brooders in this species was found to be very small. A number of pairs attempt raising a second brood but a very small percentage (about 20%) is finally able to raise a second brood.

The raising of the second brood is a common phenomenon in Brahminy Myna. About 70% of total breeding population of Brahminy

Myna raises its second brood. The greater success of raising the second brood in this species can, perhaps, be attributed, at least partially to the sheltered nature of the nest. But no third brood was observed during whole study as described by Ali and Ripley (1972 : 161).

SUMMARY

1. The mynas were selected for the study due to their close association with man, and being birds of economic importance.

2. Previous work on the breeding biology of these mynas is traced right from 1862 to date.

3. The study was conducted in nature in and around Dehradun. Some birds were ringed for specific observations by catching them with mist nests. Observations were made from behind thick bushes, stout trees, closed vehicles etc. from a safe distance. Nesting activities were watched through 5 × 30 field binoculars.

4. Nest contents were studied by climbing up to the nest or reaching the nest by a bamboo ladder, and with the help of tree climbers.

5. Specific observations were made in selected nests by making the visits at regular intervals.

6. Some nests, eggs and young ones were brought to the laboratory for recording descriptions, measurements, weights etc. Vernier callipers was used for measuring the eggs. For weighing eggs and young, single pan electronic balance was used in the laboratory, and letter balance in the field.

7. The study area (Dehradun) is situated in the middle of the Doon Valley, roughly at 78°2' east longitude and 30°20' north latitude. It has three marked seasons : Cold—November to March, hot—April to first half of June and rainy season—from later half of June to first half of October.

8. The monthly mean of daily minimum temperature at Dehradun ranges from 2.7°C in December-January to 23.4°C in July, while the mean of daily maximum ranges from 19.6°C in February to 36.9°C in May.

9. South-West monsoon is the main source of rainfall at Dehradun. Humidity increases in July and August at Dehradun.

10. Both the species of mynas breed at Dehradun annually approximately for a period of 6 months [*Sturnus contra* Linnaeus from the end of February to August and *Sturnus pagodarum* (Gmelin) from March to August].

11. The Indian Pied Myna starts breeding by the end of February and Brahminy Myna by early March when the temperature is rising, the quantum of day light is increasing and the winter rains are coming to an end.

12. Both the species of Mynas breed during the period when suitable food for their young ones is in abundance.

13. Both the species of Mynas pair up annually only for the short-duration of the breeding season. The pair formation takes place after the territory is established, by the male.

14. Mynas recognise their own species by association with the parents.

15. The mate recognition in both the species at the nesting stage appears to be through audiovisual clues.

16. The pair formation in both the species is only for the duration of the breeding season.

17. Males of both species court their mates through a distinct courtship display.

18. Both the species are monogamous. Copulation in both takes place, usually inside the territory and is most frequent during the nest building stage. It is performed in normal bird fashion.

19. Indian Pied Myna occupies a territory which exhibits a mixture of type (i) and (iii) of the Hinde's classification, Brahminy Myna keeps Hinde's (iii) type of territory.

20. The males of both the species occupy the territory before the formation of pair and defended it mainly for acquiring a mate, nesting site, clutch and brood.

21. The size of territory in both the species depends according to the temperament of the owners and the nature and the type of intruders.

22. A well developed social defence system is found in Indian Pied Myna. In Brahminy Myna only the owners defend. The defence is performed by warning calls, threat display and actual combat.

23. The main function of the territory in these mynas is to acquire a mate, afford protection to nest, eggs and their young.

24. In the case of Indian Pied Myna the normal nesting sites is fork in largish trees. Occasionally cross-bars on telephone and electric poles may be used in the areas where such trees are wanting. A hole in a tree trunk or in a wall is the usual nesting site of the Brahminy Myna. Artificial wooden nest boxes were also used by this species for the placing of the nest in.

25. In Indian Pied Myna the male appears to select a possible nesting site, but the final selection is done by the mutual consent of both sexes. But in Brahminy myna the female appears to have a final say in the selection of nesting hole.

26. Both the species of mynas use the coarser material like small twigs, pieces of stems of creepers, grasses stem, straw feathers, paper pieces, pieces of cloth, snake skins, wrappers of cigarettes, cellophane paper etc. in the construction of the nest. Nest cavity of the egg chamber is lined with comparatively softer material like fine stems and leaves of grass, hairs and cotton etc.

27. Material hunting for nest construction is done by both the sexes in both the species but most of the construction is done by the females in both cases, while the males supply the bulk of the material.

28. The Indian Pied Myna completes its nest in 7-22 days while the Brahminy Myna completes its nest in 12-25 days.

29. The typical finished nest of Indian Pied Myna is a dome shaped structure with a side entrance near the top. Occasionally open cup shaped nests are also constructed. The nest of Brahminy Myna is rough circular, pad-shaped structure.

30. Mostly the eggs are laid after the completion of the nest in both the species, but in some cases lining of the egg chamber may continue up to the laying of second egg.

31. Both the species of mynas lay one egg a day till the clutch is complete. The laying takes place generally between 06.00 hrs and 0.800 hrs in the case of Indian Pied Myna between 06.00 and 09.30 hrs in the case of Brahminy Myna.

32. The eggs of both the species of mynas are ovoid in shape. The colour of the eggs of Indian Pied Myna is blue whereas of Brahminy Myna is Pale blue.

The eggs of the Indian Pied Myna are large and heavier than those of the Brahminy Myna.

In the case of Indian Pied Myna the average annual clutch size varied from 3.8 to 3.9. The average clutch size was the largest (4.5 to 4.7) in the first half of the breeding season.

In Brahminy Myna the average annual clutch size varied from 3.8 to 4.0. The average clutch size was the largest (4.0 to 4.5) in the first half of the breeding season.

Slight variation in colour from clutch to clutch are found in both the species of mynas. But size and weight of eggs varied considerably not only in the eggs of various clutches but also in the various eggs of the same clutch.

33. Second eggs in the Indian Pied Myna tend to be heavier than the first. But no definite weight pattern was found in the eggs of the Brahminy Myna.

34. Both the species of mynas are determinate layers.

35. Incubation starts with the laying of the second egg in both the species.

36. Both in *Sturnus contra contra* Linnaeus and *Sturnus pagodarum* (Gmelin) the female does most of the incubation.

37. The male Brahminy Myna occasionally supplies food to the incubating female.

38. Incubation period of Indian Pied Myna is 14-15 days and that of the Brahminy Myna is 12 days.

39. The eggs of both the species of mynas hatch out one after the other, more or less in the same order in which they are laid.

40. Hatching success of *Sturnus contra contra* and *Sturnus pagodarum* was observed to be 89% and 93.25% respectively.

41. The young in both the species of mynas are nidicolous.

42. The newly hatched young are fleshy pink in colour in both the species, the eyes are closed, the traces of greyish white filoplumes on head, back, wing thighs and sides of abdomen are present.

43. The freshly hatched young weigh slightly less (0.475 to 0.528 grams average 0.506 gms in the Pied Myna and 0.35 to .49 grams average 0.41 grams in the Brahminy Myna) than the eggs from which they hatch out.

44. The eyes of nestling of both the species open between 5 to 8 days.

45. The feathers break out of the skin on 4th/5th day in the nestlings of both the species.

46. Fear complex develops after a day or two of the opening of the eyes in both the species.

47. The nestlings of both the species of mynas are fully fledged in 13-16 days time.

48. The feeding of the young is done by both the parents in both the species. The peak of this activity reaches by the end of the 1st

week and is more or less maintained at this level for 5 to 6 days in the Indian Pied Myna, but in the Brahminy Myna it reaches earlier by a day or two and continues up to the age of 10-11 days. As the young grow and are able to swallow more and more solid food the number of feedings becomes fewer. Food given to nestlings in the earlier stages are soft bodied insects, larvae, caterpillars, earthworms etc. Grains, fruits, seeds and whole insect etc are fed to grown up young.

49. The duties of nest sanitation are performed by both the sexes in both the species.

50. The nestling period of the Indian Pied Myna is 21 to 27 days and that of the Brahminy Myna is 18 to 21 days.

51. The nestling mortality in the Indian Pied Myna during the period of study was found to be 44.59%. Most deaths occurred owing to the fall of the nest on account of strong gusty winds. In the case of the Brahminy Myna the nestling mortality was found to be less, it was observed to be 32.6%. Shortage of food, especially during first week, and predation were the main factors of nestling mortality in both species.

52. Some of the early breeders raise a second brood in both the species of mynas.

53. After the departure of the first brood the same territory is maintained by the nesting pairs in both the species of mynas.

54. The courtship routine is performed once more in both the species before raising the second brood.

55. Repairs of nests (occasionally construction of a new nest within the same territory in the case of the Indian Pied Myna) starts after one week of the departure of first brood in both the species of Mynas.

56. Repairs of the nest may take 3-6 days time in both the species. A new nest may be constructed by the Indian Pied Myna in about 7-9 days if the first one is blown out or is beyond repair.

57. A second peak of copulation is reached while the nest repairs are in progress for raising the second brood, in both the species.

58. Laying pattern is similar in second brood as in the first brood in both the species. But the clutch size in the second brood is smaller than the first brood in both the species.

59. The incubation period, hatching pattern and the nestling period for the second brood remain the same as in first in both the species.

60. The rate of development of the young of the second brood was slightly quicker than that of the first brood in the case of the Indian Pied Myna, whereas it was almost same in both the broods in the Brahminy Myna.

61. About 20% of total breeding population of the Indian Pied Myna raised its second brood, whereas as many as 70% of the breeding pairs of the Brahminy Myna raised their second broods.

62. No third brood was observed to be raised in any of these species.

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PLATES

[Indian Pied Myna]



Fig. 15. Nesting material being brought in.



Fig. 16. Male guards while female does most of the construction



Fig. 17. Construction in progress



Fig. 18. Female adjusting a trajecting twig.



Fig. 19. Finer and softer materials are being used for the construction of the egg chamber



Fig. 20. Harmless birds like House Sparrow are allowed to come very close to the nest.



Fig. 21. Courtship display of the male



Fig. 22. Preening of the feathers is an interlude during the nest construction



Fig. 23. The finished nest is a rough dome with a lateral opening



Fig. 24. The opening usually faces the fork

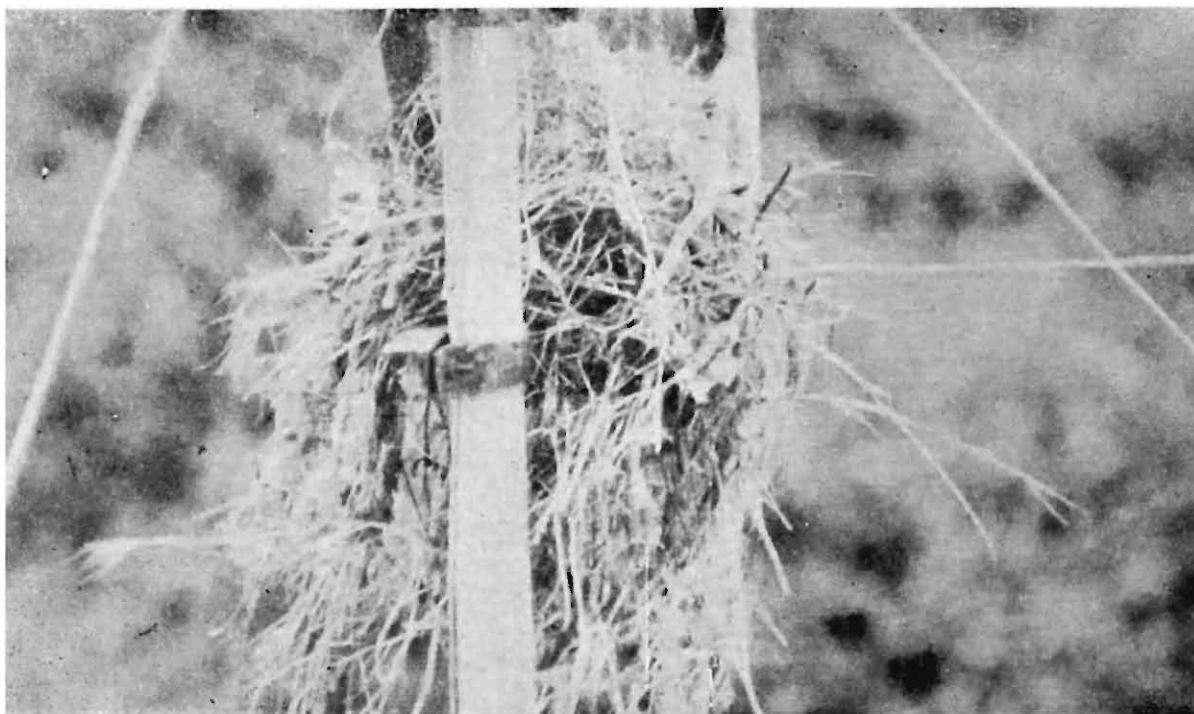


Fig. 25. Occasionally a nest may be placed on an electric pole



Fig. 26. The egg chamber is made up of finer and softer materials

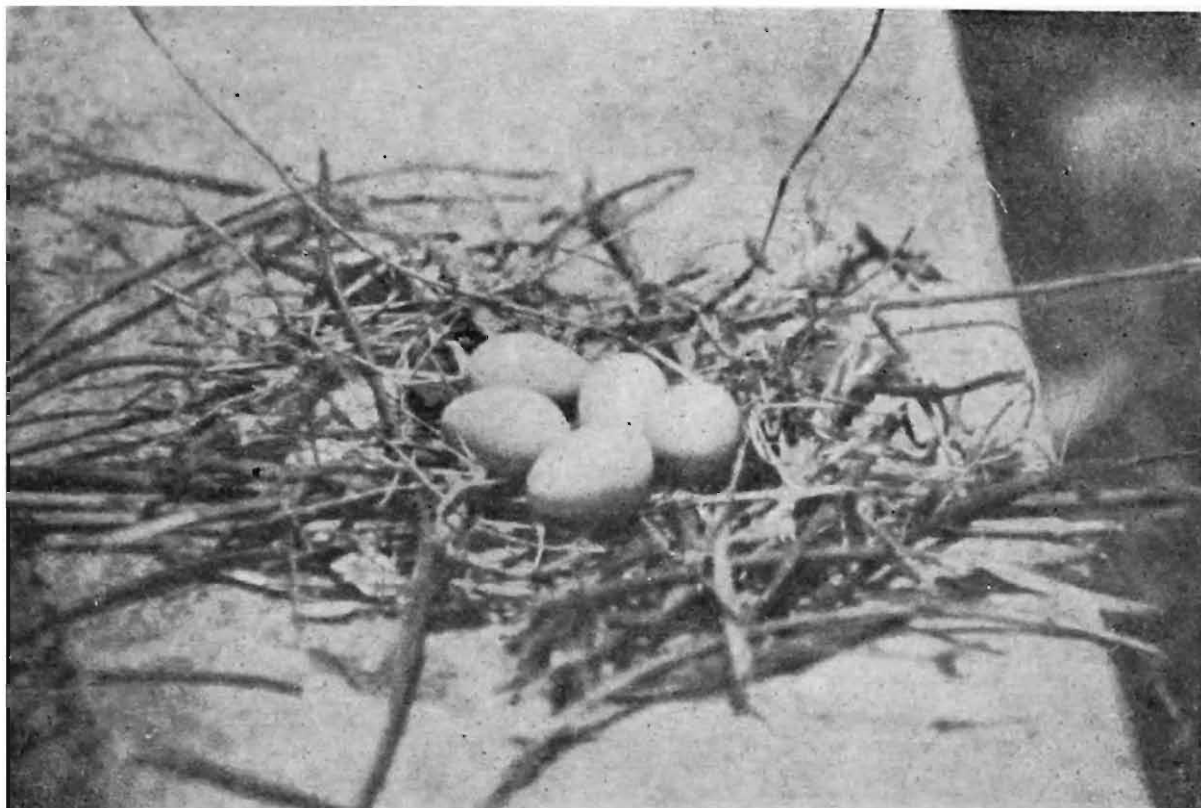


Fig. 27. The eggs are ovoid in shape and colour of the eggs is blue



Fig. 28. The male hangs around the nest while the female is incubating.



Fig. 29. During the hotter part of the day the female may come out of nest leaving the incubation to atmospheric heat.



Fig. 30. Calling the mate during incubation for incubational relief.

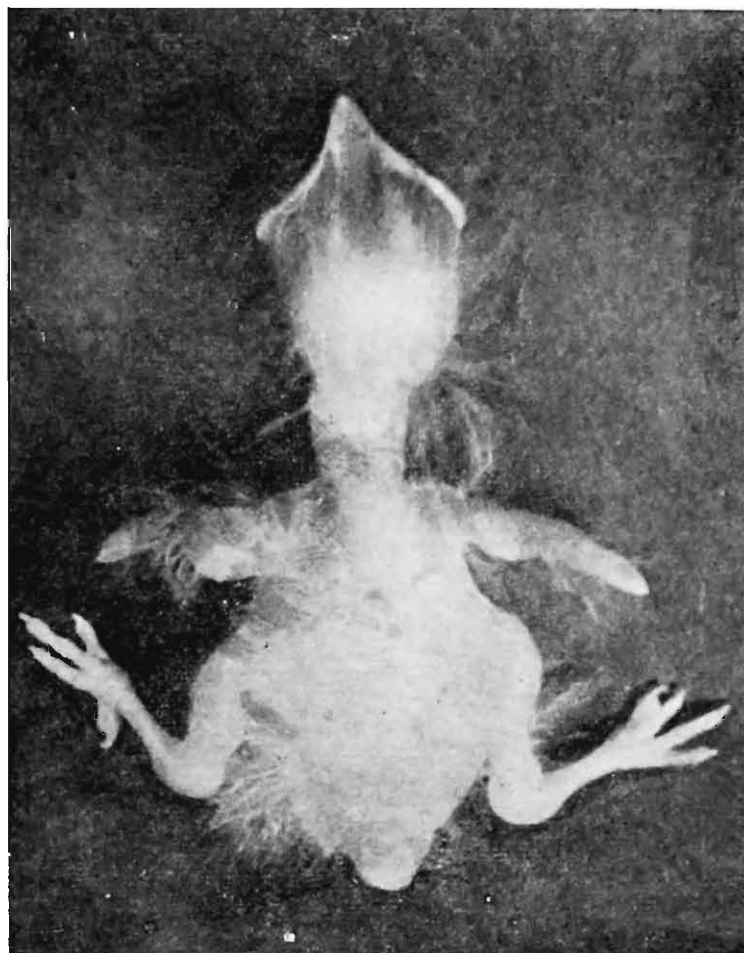


Fig. 31. Dorsal view of the freshly hatched young of Indian Pied Myna



Fig. 32. Ventral view of the freshly hatched young of Indian Pied Myna.

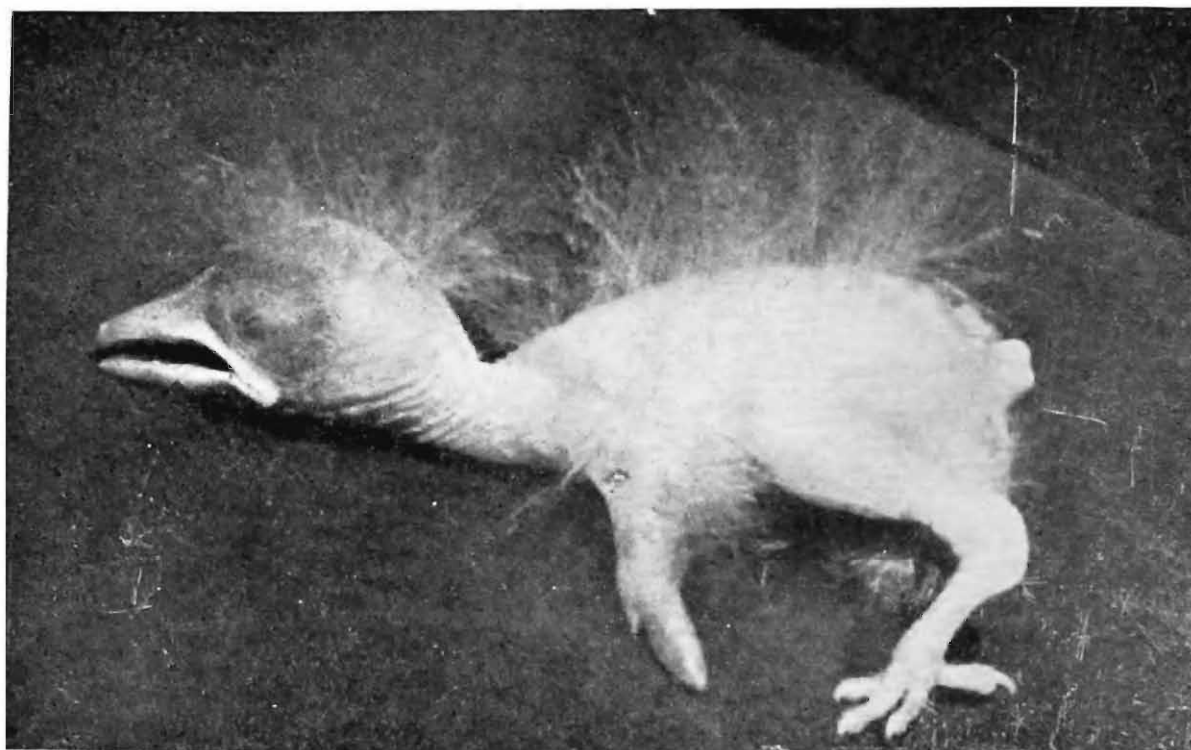


Fig. 33. Lateral view of the freshly hatched young of Indian Pied Myna



Fig. 34. A parent bringing the food for the young

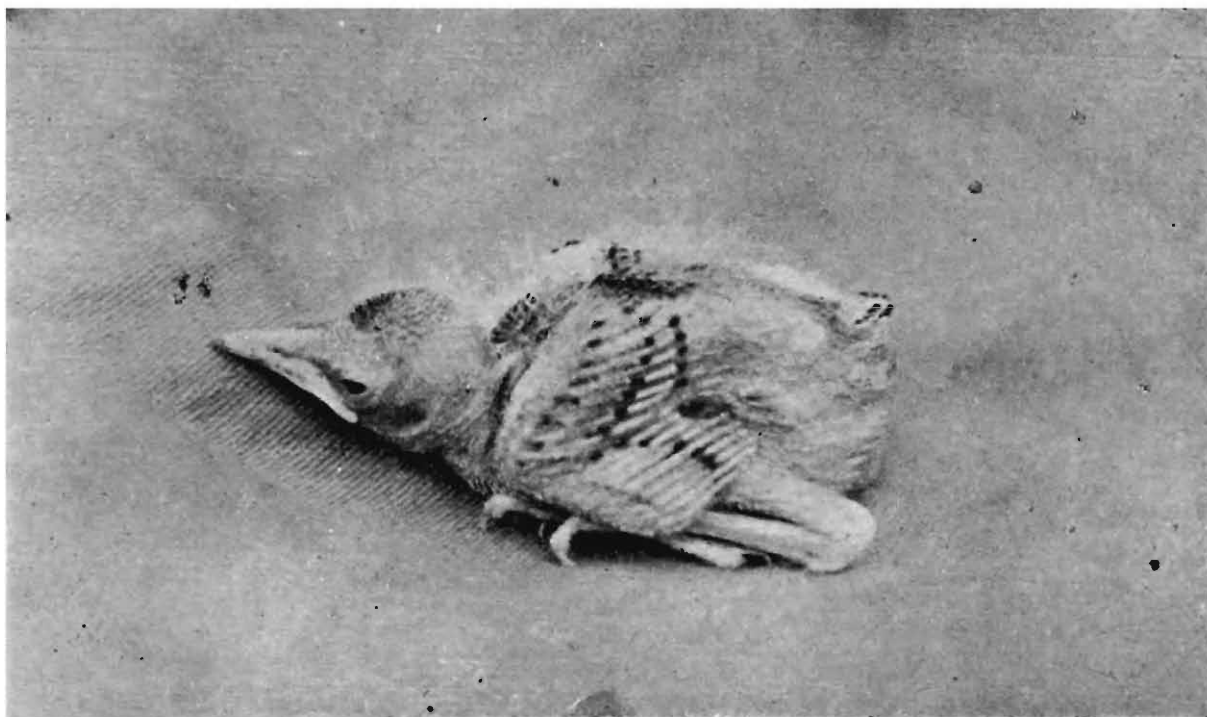


Fig. 35. One week old young of Indian Pied Myna (Single)

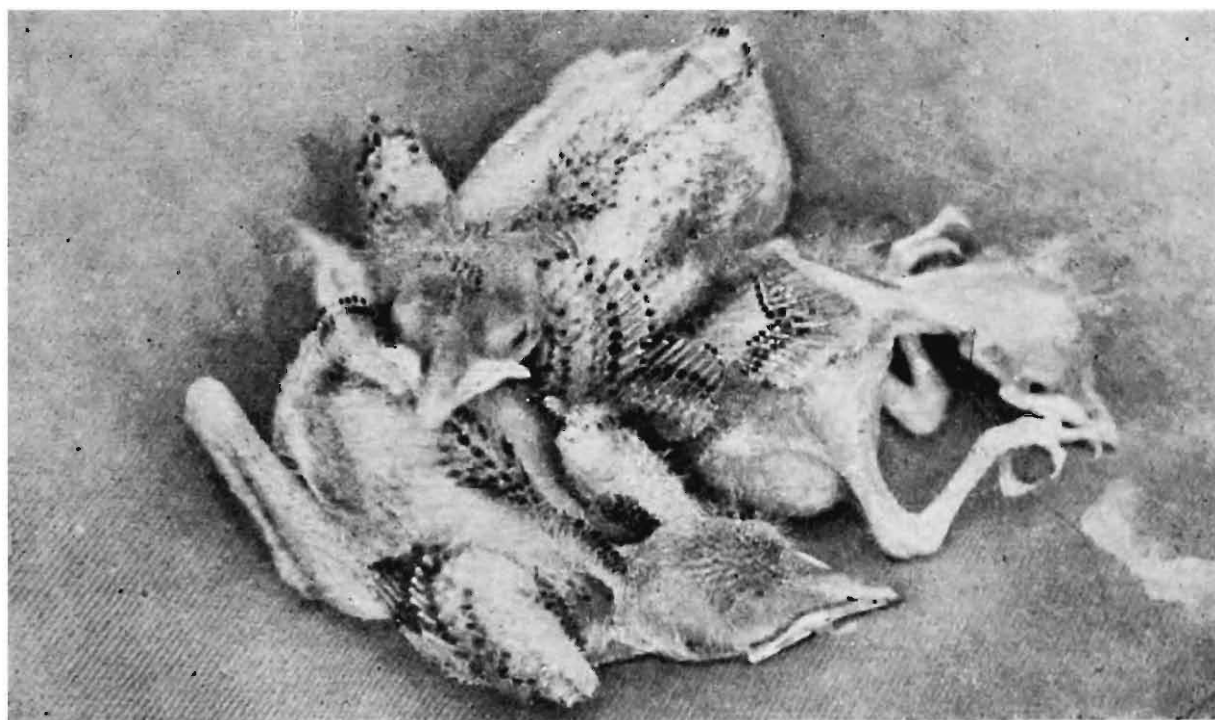


Fig. 36. One week old young of Indian Pied Myna (Group)



Fig. 37. About two week old young of Indian Pied Myna

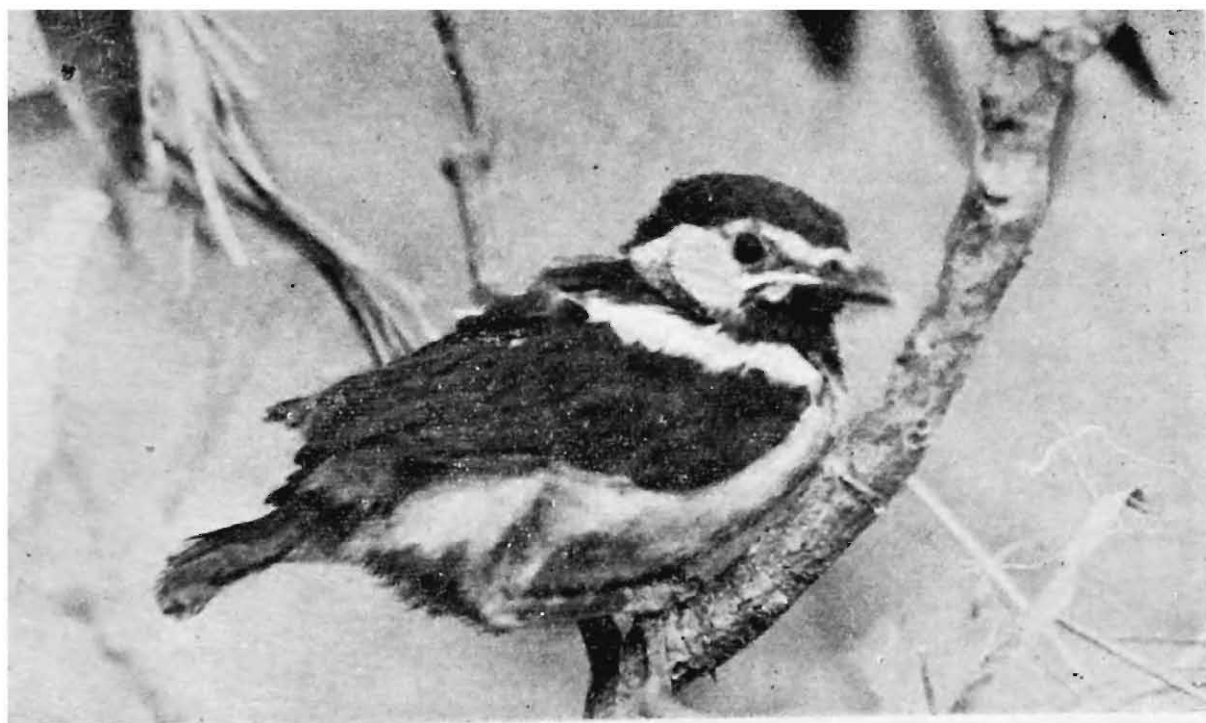


Fig. 38. Eighteen days old young of Indian Pied Myna (Single)



Fig. 39. Eighteen days old young of Indian Pied Myna (Group)



Fig. 40. Construction under progress, bird trying to introduce a bigger twig in the entrance hole of the box



Fig. 41. Nest as constructed in a nest box



Fig. 42. Clutch of the Brahminy Myna. The eggs are ovoid in shape.



Fig. 43. The colour of the eggs is pale blue



Fig. 44. Female coming out of the nest for relief



Fig. 45. Freshly hatched young of Brahminy Myna.

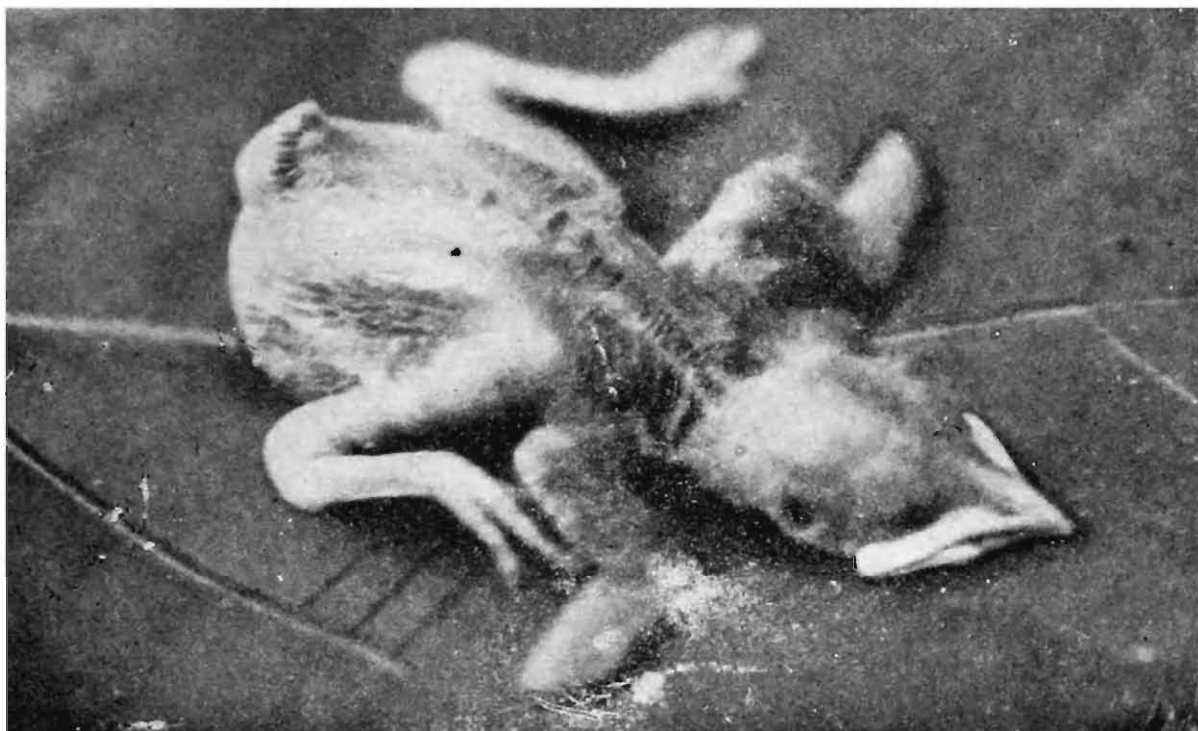


Fig. 46. Dorsal view of one day old young of Brahmin Myna



Fig. 47. Ventral view of one day old young of Brahmin Myna



Fig. 48. Lateral view of one day old young of Brahminy Myna



Fig. 49. A parent arriving at the nest with the food material for the young.

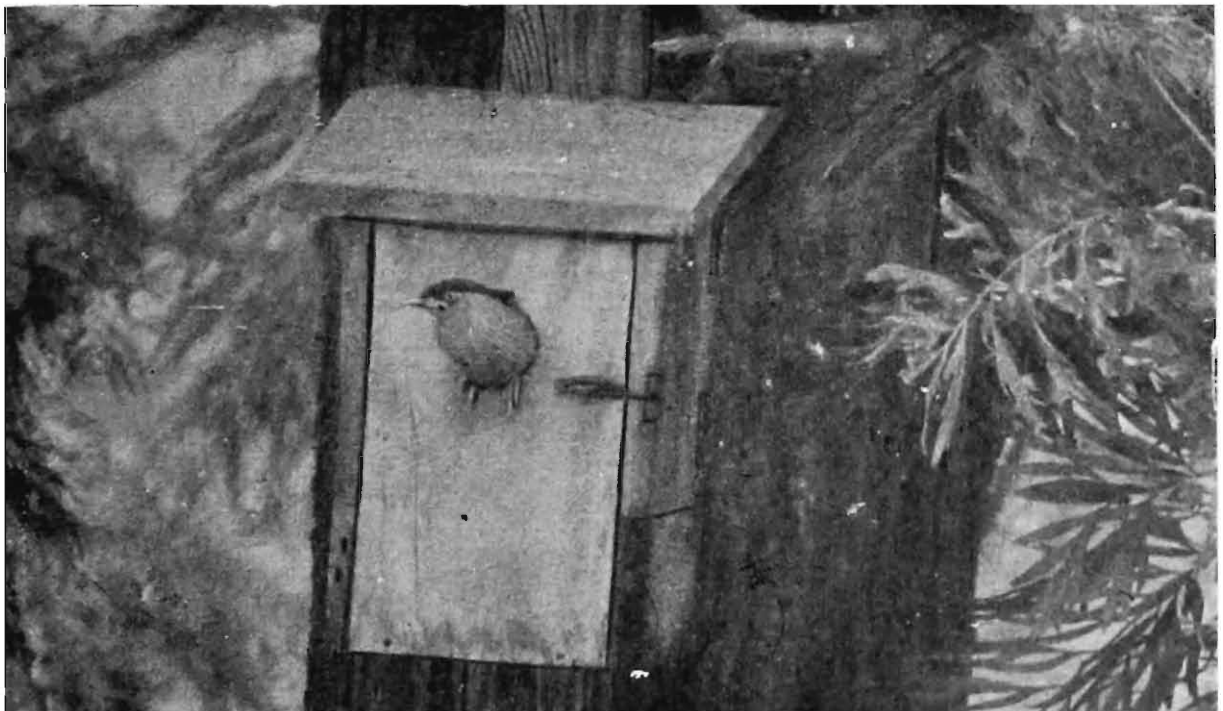


Fig. 50. Nest sanitation faecal pellet being carried away by the parent after a feed.



Fig. 51. One week old young of Brahminy Myna (Single)



Fig. 52. One week old young of Brahminy Myna (Group)



Fig. 53. Two week old young of Brahminy Myna (Single)



Fig. 54. Two week old young of Brahminy Myna (Group)



Fig. 55. Two and a half week (17 days) old young of Brahminy Myna (Single)

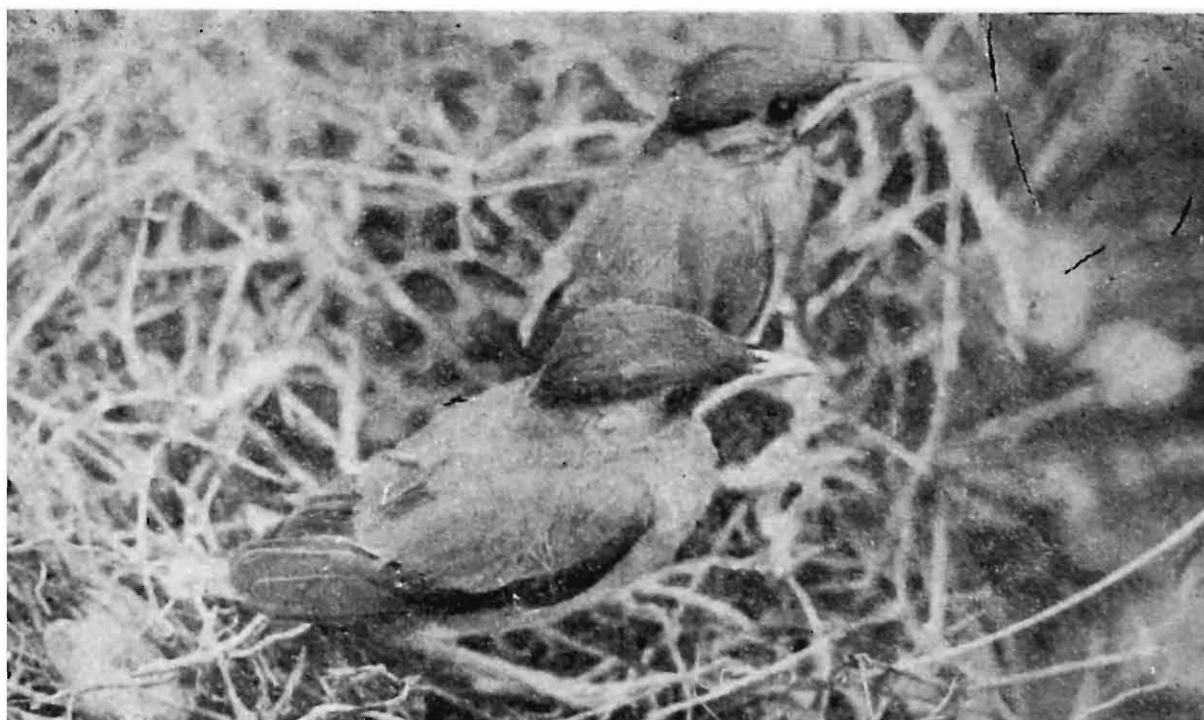


Fig. 56. Two and a half week (17 days) old young of Brahminy Myna (Group)