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THE INDIAN CROWS
A CONTRIBUTION TO THEIR BREEDING BIOLOGY, WITH NOTES ON BROOD PARASITISM ON THEM BY THE INDIAN KOEL

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(With 9 Text-figures, 3 Plates & 35 Tables)

INTRODUCTION

The family Corvidae in which crows, jays and trees pies are placed is characterized largely by a longish stout bill that exceeds its depth in length; a non tubular tongue; nostrils clear of the line of forehead and hidden by feathers and bristles; wing with ten primaries, the first exceeding half the length of the second, tail with twelve rectrices; sexes absolutely alike; and an autumn moult only.

The crows, the elite of Corvidae, have been very closely associated with man from times immemorial. In India the crows, *Corvus macrorhynchos* Wagler and *Corvus splendens* Vieillot [along with the Common Myna, *Acridotheres tristis* and the House Sparrow, *Passer domesticus* (Linnaeus)], are the most common birds that haunt the abode of man. They are very widely distributed in India and occur almost everywhere where man dwells, the House Crow, comparatively closer to man, generally frequenting the villages, towns and cities and the Jungle Crow the country side and forested hill tracts, often overlapping. The House Crow slides into rooms of human habitation alert and keen, ready to retreat at the least alarm, and with a sudden dash and bounce remove the edibles from the kitchen or table. It robs children of their tidbits and shop-keepers and vendors of their fare when left unattended for a moment. It plunders eggs and young of not only poultry, but also of wild birds. The Jungle Crow joins it sometimes to vastly damage agricultural crops, fruits and vegetables in the rural areas

throughout India. The Koel, *Eudynamys scolopacea* (Linnaeus), is perhaps the only creature who has been able to get the better of these shrewd birds. This species of parasitic cuckoos, whose breeding season happens to coincide with that of the crows, has developed a highly successful technique of duping the clever crows by secretly laying in their nest and making them toil to raise the fosters.

By their close proximity, cunning, cleverness and industry the crows have carved a place for themselves not only in some early Indian literature but also in tradition, legend and folklore in different parts of the country. In *Tulsi-krit Ramayana,* one of the most revered Hindu religious literary works, one finds an honoured place for the wise and learned CROW SAGE *Kagabhushunda.* A part of *Sankalpa* in 'Shradh' ceremony (A yearly feast in memory of and for the benefit of ancestors among the Hindus) is offered to crows in many parts of Northern India. 'Clever as a Crow' is an everyday dictum of Indians. It is commonly believed in some parts of India that cawing of a crow at one's residence is a forecast of the arrival of guests. Equally widespread is the belief that children slow at talking get rid of the defect quickly if given water partaken by a crow. Many people in rural Central India still believe that one goes blind if one happens to see the crows copulating.

Inspite of their familiarity and popularity, very little is known about the breeding habits of these crows. In fact, deplorably little is known about the breeding habits of most Indian birds although the studies on breeding habits of Indian birds were started more than a century and a quarter ago in eighteen thirties when pioneers like Blyth, Hutton and others contributed articles containing their observations on the nesting habits of Indian birds in the Journal of the Asiatic Society of Bengal. Very few ornithologists or naturalists pursued such studies in those days. The publication of Jerdon's mounumental 'Birds of India' (1862-1864) containing delightful field notes (including nesting habits) on the species dealt therein, stimulated many others to take up similar field-studies. A few years later Hume's (1869) 'My Scrap Book or Rough Notes on Indian Oology' inspired a large number of workers to take up the subject seriously. In response to Hume's appeal (made in 'My Scrap Book') for nidification data, as many as sixty-two regular and innumerable irregular correspondents from all over the country started flooding him with original fieldnotes on the nidification

of various species of Indian birds. The wealth of information thus received was so great that Hume was able to bring out his 'Rough Draft of Nests and Eggs of Indian Birds' in 1873 merely four years after the appeal was first made. Later, Oates (1889-1892) revised Hume's 'Nests and eggs of Indian birds' inserting additional data here and there. Hume's work remains, even today, a conspiquous landmark in the nidification studies of Indian birds. This wealth of knowledge left behind by Hume was further enriched by Baker through his volumes on 'Nidification of the birds of the Indian Empire' (1932-1935).

These valuable contributions of Jerdon (1862-1864), Hume (1873, 1889-1892) and Baker (1932-1935) are, however, restricted to a limited number of aspects of breeding behaviour. They deal mainly with the topics like length and number of breeding seasons, situation, location and description of nests, materials used in nest construction, number of eggs laid and their description. They fail to throw any light on aspects like pair formation, duration of bond, courtship behaviour, number of mates, territory, defence, mode of construction of nest, share of sexes in construction, laying pattern, share of sexes in incubation, period of incubation, hatching pattern and success, description and categories (nidicolous or nidifugous) of freshly hatched young, care and feeding of the young, nest-life, nesting success and nestling periods, etc., presumably because these were not studied in those days.

With the emergence of modern trends in the study of breeding behaviour of birds, it has become essential to study these so far neglected aspects in detail. With this object in view the present study on *Corvus splendens* Vieillot and *Corvus macrorhynchos* Wagler was undertaken. While studying the breeding behaviour of crows, similar studies on their brood parasite, the Indian Koel, *Eudynamys scolopacea* (Linnaeus) could not possibly be over looked as their breeding is very intimately connected.

Previous work

Jerdon (1862-1864) gave short accounts of nesting habits of *Corvus splendens* Vieillot, *Corvus culminatus* Sykes (a synonym of *C. macrorhynchos* Wagler) and *Eudynamys orientalis* Linn. (a synonym of *E. scolopacea* Linn.) quoting therein the contributions of earlier workers like Blyth, Firth and Hutton. His account

of crows gave information on the length of breeding season, nesting sites, description of eggs and defence of nest and young. The account of the koel enumerated the number of host-species, laying habits like the number of eggs laid in a single nest and destruction or removal of crows' eggs at the time of laying its own, and its supposed habit of taking care of its own young after they left the crows' nest. It also made a mention of crows' dislike of the koel.

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. His (Hume, 1873) collation covered all the topics touched upon by Jerdon (1862-1864) but in much greater details. He included many verbatim accounts of other workers giving details of their discoveries or findings on nests and eggs. A revised edition of his (Hume, 1889-1890) work 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. Some of these workers made a mention of the care of the young in crows (Cockburn, *in* Hume, 1889 : 7) or occupation of the same site by some crows year after year (Aitken, *in* Hume, 1889 : 10-11). The koel's nidification data comprised of Hume's (1890) own observation in detail and those of other workers (and correspondents) to date on the topics initiated by Jerdon (1862-1864). Conclusions of various workers from different parts of the country on controversial topics like the Indian Koel's habit of destroying one or more eggs of the crow at the time of laying its own and ejection by the young koel of its companions, if any, from the nest, were also listed.

Dewar (1905) gave very valuable information on some hitherto untouched aspects of the House Crow's breeding habits, like the courtship behaviour, mode of construction of nest, share of sexes in nest construction and feeding and care of the young. He (Dewar, 1907) also conducted an enquiry into the parasitic habits of the Indian Koel to ascertain the following :—

i) Does the hen koel first lay her egg upon the ground and carry it to the nest in her beak, or does she sit in the nest and lay it ?

ii) Does she take away or destroy the crow's eggs that are already in the nest ?

iii) Does the young koel, like the common cuckoo, eject its foster brethren ?

iv) Is the incubation period of the koel shorter than that of the crow ?

His experiments (based on observations of a number of nests) were greatly interfered with by the urchins of the locality, as a result of which he could not prove or disprove item nos. (i) and (ii) of his enquiry. He concluded, however, that the young koel does not eject its foster brethren and that the incubation period of the koel is shorter than the crow's.

About 40 years after Hume's collation, Baker (1932-1935) compiled accounts of nidification of various subspecies (including the three species under study) without substantially enriching the information supplied by Hume. He also did not apparently draw from Dewar's (1905, 1907) original and valuable contribution while making his compilation.

After Dewar's basic account of breeding behaviour of the House Crow (Dewar, 1905) and the Indian Koel (Dewar, 1907) no substantial contribution was made to the subject, although a large number of workers before and after him (Adam, 1873; Butler, 1875; Legge, 1875; Marshall, 1877; Davidson & Wenden, 1878; Cripps, 1878; Scully, 1879; Doig, 1879; Vidal, 1880; Ried, 1881; Swinhoe & Barnes, 1885; Barnes, 1886, 1889; Davidson, 1887, 1898; Taylor, 1887; Oates, 1889; Munn, 1894; Inglis, 1896; 1901, 1903, 1908, 1931-1934; Jesse, 1902; Laster, 1903; Ferguson, 1903; Harington, 1904; Toche, 1905; Dewar, 1909, 1929; Osmaston, 1906; Ward, 1906; Baker, 1906, 1917, 1922, 1926; Mason & Maxwell-Lefroy, 1912; Jacob, 1915; Jones, 1916, 1919; Currie. 1916; Whistler, 1916a, 1916b, 1923, 1963; Field, 1922; Gill, 1922. 1925; Fletcher & Inglis, 1924; Prater, 1926; Ali, 1926, 1953, 1961; Berriff, 1927; D'Abreu, 1927; Andrews, 1928; Baker & Inglis, 1930; Abdulali, 1931; Bates, 1931; Briggs, 1932; Burton, 1935; Varghese, 1935; Baba Sahib, 1936; Rao, 1936; Ali & Abdulali, 1937; Sen, 1947; Aitken, 1947; Lowther, 1949; Acharya, 1951; Bates & Lowther, 1952; Smythies, 1953; Betts, 1953; Dharmakumarsinhji, 1954; Jamal Ara, 1954; Hutson, 1954; Henry, 1955, to mention a few) have published their observations on one or more aspects of the breeding behaviour of these species.

Dharmakumarsinhji (1954 : 136) has written about the female koel trying to lay without the assistance of the male as

well as on the female koel sometimes helping another female koel to lay her egg. He has also made a mention of promiscuous sex relationship in koel. In the same year the defence of territory by male and female koel was described by Hutson (1954 : 114) for the first time although he preferred to call it 'display activity'. MacDonald (1960 : 127-137) too gave an interesting account of courtship chases, free sex-life and defence of territory in koel.

Nidification studies of these three species of birds were first undertaken by me in 1953 when I was attached to the Virus Research Centre, Poona. In that year the Virus Research Centre became interested in avian nestlings as potential arthropod-borne-virus reservoirs and propagator. While observing the nests of the common species of birds in and around Poona for nestling studies, a large number of House Crow and Jungle Crow nests came under my purview. The data on the breeding behaviour collected as a by-product of the nestling studies turned out to be so interesting that studies on breeding behaviour were started simultaneously. Inspite of three years' (1955-57) observation at Poona large lacunae remained in the data on many of the aspets. Hence, observations were continued at Vellore (N. Arcot, Madras) in 1956 and Akividu (W. Godavari, Andhra) in 1957 where the I was stationed. The results of these observations on *Corvus splendens, Corvus macrorhynchos* and *Eudynamys scolopacea* have already been published (Lamba, 1963, 1965). These accounts, although they described in detail many of the hitherto unknown or lesser known aspects of the breeding habits of these species, failed to cover the subject completely. Therefore, the present study was undertaken during 1965-1967 at Poona where the author was posted during these years.

MATERIAL AND METHOD

The birds were observed in the study area with the naked eye and through 8 × 50 prismatic field binoculars whenever necessary. Observations were started well in advance of the breeding season.

Prior to the nest-building stage if for any reason, the sex of a crow was required to be determined, it was so done by actual examination of its gonads by dissection after shooting it with a fire-arm. At the nest-construction stage and afterwards

one (or both) of the owners of the nest was (were) captured with Japanese mist nests and ringed with coloured plastic bands for recognition.

The mode of construction of nest was watched from a safe distance and as far as possible from within a parked vehicle or from behind a hide in order to avoid frightening away the birds who were very sensitive to long objects pointed at them. The hide used was a very primitive one, which is commonly used by Phasi Pardis (bird-catchers) in the State of Maharashtra. It consists of a fawnish khaki canvas sheet stretched over a cross of thin bamboo sticks with their ends holding the four corners of the sheet, thus converting it into a somewhat curved screen. A small observation hole, about 4 × 9 cm, that is normally made by the Phasi Pardis, was enlarged by me to 8 × 12 cm, so as to accommodate my binoculars. This hide was very light and could be easily carried while stalking the birds. For stationary observations it could be propped against a stick or a tree and a folding stool put behind it for the observer's comfort.

The material used for the construction of nests and measurements of completed nests were determined and recorded from a score or so of nests brought to the laboratory for the purpose.

About 24—48 hours since the birds were first observed to bring in the lining material, regular observation of the nest proper were started by climbing up the nest tree or a ladder reaching the nest if possible. For observations of a few inaccessible nests on very thin branches, the help of small boy climbers was taken, who would shout about the contents of the nest or lower them down in a small tin container for making observations or taking notes. These contents, after the needful, were again pulled up by them and replaced. As far as possible efforts were made to visit individual nests at fixed hours, usually the hour at which the nest was first visited. During the laying and hatching periods a number of selected nests were visited in the mornings at 7.00 to 7.30 hours and 10.30 to 11.00 hours and again in the evening at 19.00 to 19.30 hours. In addition to these regular visits, irregular visits at dusk, night and dawn were also made to selected nests for certain specific observations. The eggs for general study were brought to the laboratory. Their measurements were taken in millimetres with a pair of vernier callipers, and their weights were recorded on a chemical balance true to 0.1 gram. The colours of the shell

and markings were deciphered, as far as possible, with 'Methuen handbook of Colour' Successive eggs of a selected number of clutches were measured and weighed in the field itself for a comparative study of size and weight at laying.

The eggs for incubation studies were dated with indelible Indian ink.

In a number of nests the young, soon after hatching, were banded with coloured plastic bands, various colours indicating various numbers in the order of their emergence. The young were weighed periodically in the field on a letter balance true to 0.5 gram. Nestlings more than 10 days old were put in cloth bags to keep them calm and immobile during the operation. The weight of the bag and faecal matter if any discharged in it while weighing was reduced from the total weight of the cloth bag with nestling inside. For describing the nestlings at various stages of acquiring feathers, etc., some nestlings were brought to the laboratory. Such nestlings were generally sacrificed to ascertain the food on which they were being fed.

The incubational changes, feeding of young and nest life in general was watched from a distance through 8 × 50 prismatic field binoculars either from within a parked vehicle or from behind a hide as already described.

The photographs of the nests, eggs and young were taken with a 35 mm Asahi Pentax camera with a normal 55 mm lens and a 300 mm telephoto lens, from a parked vehicle, or from behind the hide or in the laboratory.

The study area was mapped and general notes were kept on the ecological conditions. The data on weather conditions was secured from the Meteorological Station, Poona.

HABITS, HABITATS AND ECOLOGY

Habits and Habitats

Both the species of the crows and the koel were studied in nature. Either one or both the species of crows are found throughout the length and breadth of the country wherever man dwells, may it be a desert or a tropical forest, a low lying plain or high mountain range. Throughout the day the House Crow robs his kitchen, table, children, crops, orchards, shops, pets and poultry. Wherever present the Jungle Crow joins it

to scavange the filth around his abode including left-overs of meals, kitchen refuse, nightsoil, dead vermin, pets and cattle.

The House Crow, *Corvus splendens,* is gregarious in its habits. More often than not it moves about in small flocks, with the members scattering in a small area in search of food. On spotting food or locating an enemy an invitation or alarm call, as the case may be, is given out by the discovering individual. In the case of announcement of food, a few of the species within the ear-shot, probably of the same batch or flock, rush to the spot to try their luck or to partake of the feast. But the alarm call is taken up by all members of the crow community within the hearing distance and relayed, thereby spreading it to a much greater area, from which all individuals rush, leaving all other occupation, to the scene of excitement may it be a snake, a dead crow, an ornithologist interfering with nests or young, a fallen nestling or a lurking koel. Soon the locality (neighbouring trees, house-tops, telephone and electric wires, etc.) teems with scores of agitated and cawing House Crows. Many of the assembly, not content with cawing, circle overhead defecating and diving to peck at the offending object. In the non-breeding season at night the House Crows often roost together in enormous numbers (app. 300 to 900 birds in a single roost) in large trees, generally on the outskirts of human habitation. Approximately half an hour before sunset batch after batch of these crows crossing overhead in a single direction (of the roost) is a very common sight in rural India. The roosts, invariably large trees with sizeable spread of branches, are often shared with the Common Myna (*Acridotheres tristis* Linnaeus) and the Paddy Bird (*Ardeola grœvii* Sykes). At day break the process is reversed and large numbers of small batches of these crows are seen flying in the opposite direction, *i.e.,* from roosts to the feeding areas.

The Jungle Crow, *Corvus macrorhynchos,* is not so gregarious as the House Crow. Except in cities and towns it is often met with in pairs or small parties of three to five birds. In cities and towns it simulates the House Crow and often join the latter in its diurnal activities. Its roosts are never crowded, and it does not roost with the House Crow.

One thing that is indisputably common to both these species of crows is the fact that wherever they are found they breed. And wherever they breed the koel is bound to turn up sooner or later to parasitize their broods. The suburbs of Poona, where

the present study was undertaken were found to be naturally rich in the materials of the present study, *i.e.*, the two species of crows, *Corvus splendens* and *Corvus macrorhynchos*, and their brood parasite the koel, *Eudynamys scolopacea.*

Study area

Physiography

Studies on the breeding behaviour of crows and koel were carried out during the years 1965 to 1967 at Poona, *i.e.*, within the Municipal Corporation limits of Poona and Cantonment Board limits of Poona and Kirkee Cantonments (Plate IV, Fig. 9) ; mainly from Parvati, Gultekdi, Satara Road, Salisbury Park, Shanker Seth Road and Khadakwasla Road (Plate V, Fig. 10).

The city of Poona, 'the Queen of the Deccan' as it is popularly known, lies to the north-west on the Deccan Plateau, east of the Western Ghats on altitude 18°30′ north and longitude 73°53′ east, at a height of 490 metres above the sea level. The city (including the Cantonments of Poona and Kirkee) has an area of approximate 53.7 square miles (153.3 square kilometres). It is surrounded by beautiful uplands and hills and is traversed by the Mula and Mutha rivers which enjoin to form the Mula-Mutha river in the city.

The old city of Poona is mainly a residential town, and like all old cities, is ill-planned and overcrowded. The suburbs of comparatively recent origin and the cantonments of Poona and Kirkee are well-planned, well laid-out and well-developed urban areas. In addition to being a renowned centre of education, seat of administration of the Maharashtra State Government and a military Station (Head Quarters of the Western Army Command), Poona has, of late, became a big industrial centre with innumerable industries springing up on its periphery, especially on the north-west and east.

As already stated, two rivers, *viz.*, Mula and Mutha enjoin at Poona to form the Mula-Mutha river. The Mutha river which originates from the edge of the Sahyadris enters the city from a south-western direction, separating the old Poona city which lies on its right bank from Deccan Gymkhana and Shivaji Nagar (suburbs of comparatively later origin) which are located on the left bank. The Mula river which is in fact formed by seven streams arising at various points along the crest of Sahyadris,

enters the Kirkee Cantonment from the west flowing for a while to the north-east and then turning south in a double loop, north of old city joins the Mutha at a point called Sangam. As both these rivers are dammed on their way to Poona the flow of water in them is very much restricted except in the rainy season. The combined Mula-Mutha river flows out of Poona in an easterly course keeping to the north of the Poona Cantonment.

This river system provides much of the soil moisture essential for the growth of plants, especially larger trees in which most crows roost, build their nests and on whose fruits the crows and koels feed. Approximately, 96 species of trees are met within Poona and about half the number are utilized by crows and koels for nesting, feeding and roosting. These trees mostly line the roads of Poona and Kirkee Cantonments and well-to-do suburbs. 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 crows and koels. There are also two big gardens (and a number of smaller ones) in Poona, *viz.*, Botanical garden at Ganeshkhind and Empress garden (60 acres) opposite the Race Course at Poona Cantonment. Both of them attract a large number of birds including the crows and koels.

In between the large housing complexes of the city and cantonment there are stretches of agricultural and waste lands. The agricultural lands, used mainly for growing vegetables, are another big attraction for crows.

Climatic factors

Possessed of a high altitude, and with the prevalence of cool westerly breezes, Poona has a mild and pleasant climate. It does not get very hot in summer or very cold in winter. Even during the rains it is not very humid. Although Poona has a climate characterised by large diurnal range of temperatures [The variation between the mean of minimum (early morning) and maximum (afternoon) temperatures some times being as much as 20°C (Text-fig. 1)]; the variation in the monthly mean of daily minimum temperature of hottest and coldest months and daily maximum temperature of the hottest and coldest months seldom exceeds 12°C.

Seasons : Generally speaking the year in Poona may be divided into three main seasons ; the cold season from November to February, the hot season from March to May and a wet season from June to October ; October is, however, more hot than wet.

In the cold season, dry easterly land winds prevail during most part of the day and cool westerly winds from the sea at night. From February onwards, there is a sea breeze in the evening. By about the middle of March, the temperature rises somewhat rapidly and hot breeze of variable direction prevails during day time. The hot season may be said to begin from the middle of March and end by June, though the hot winds and other characteristics of hot weather are mostly over by the middle of May. In the months of April and May the maximum temperature at Poona often rises above 38°C. During the hot season there is heat and dust haze. April and May, though the hottest months, are not the driest ones. Towards the close of May, a couple of pre-monsoon thunderstorms occur followed by rain. The wet season proper may be said to be ushered in by the south-west monsoons sometimes in the second week of June, and it lasts till the middle of September.

Rainfall : The south-west monsoon is the main source of

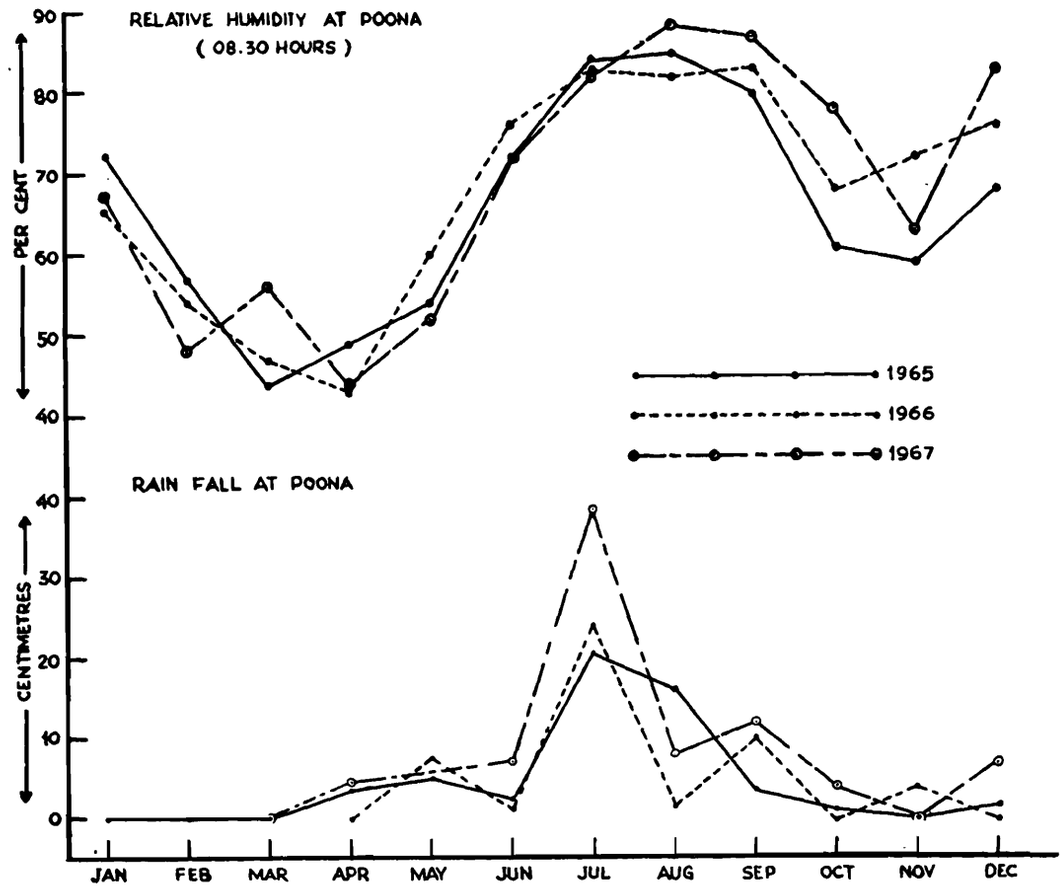
TABLE I.—*Monthly mean rainfall (in mm.) during the study period 1965-1967.*

Years	Months					
	January	February	March	April	May	June
1965	1	0	0	33	49	26
1966	0	0	0	0	75	14
1967	0	0	0	37	32	67
	July	August	September	October	November	December
1965	204	160	32	10	0	15
1966	242	16	101	3	39	1
1967	384	78	124	40	0	72

rains in Poona though occasional thunder showers in May or October may be met with. The south-west monsoon breaks over Poona by the middle of June and lingers on till the middle of October. The average annual rainfall, as recorded by the Meteorological Station, Poona, is 662.25 mm. The maximum rainfall recorded is 1293.1 mm. (in 1892) while the lowest recorded is 335.3 mm. (in 1899) The heaviest monsoon rainfall and the greatest number of rainy days occur in July.

Monthly mean rainfall during the breeding seasons of the birds studied for three years of study (1965-1967) is given in Table 1, and in Text-fig. 1.

Humidity : Being situated on the leeward side of the Western Ghats, Poona remains comparatively dry even in the monsoon, the mean monthly relative humidity seldom exceeding 84 per cent. The diurnal variation of humidity is least in monsoon months. March and April are the driest months. On a few days in May and sometimes in early June before the onset of



Text-fig. 1

rains, nights in Poona become rather uncomfortable on account of high temperature combined with fairly high humidity.

The monthly mean humidity for the 3 years of study (1965-1967) is tabulated in Table 2, and in Text-fig. 1.

TABLE II.—*Monthly mean relative humidity (in %) during the study period 1965-1967.*

Years	Months					
	January	February	March	April	May	June
1965	72	57	44	49	54	72
1966	65	54	47	43	60	76
1967	67	48	56	44	52	72
	July	August	September	October	November	December
1965	84	85	80	61	59	68
1966	83	82	83	68	72	76
1967	82	83	82	78	63	83

Winds : The direction of the prevailing wind is north-west to west in January and February. With the commencement of hot weather, the direction slowly changes to the west and continues westerly right up to the end of the monsoon in September. October is a month of variable winds, while easterly winds predominate in November and December. During May and the rainy season the direction of the wind all through the day is from the west. From the months of October to February calm prevails in the morning approximately between 8 and 10 hours. Before the period of calm the direction of the wind is westerly. After the calm easterly wind begins and continues till 19.00 hours in October, November and December. After 7 O'clock in the evening the direction changes and the westerly breeze starts. In January, February, March and April the period of easterly winds lasts only for a few hours from 10 O'clock onwards. Though Poona is situated well to the east of Western Ghats, towards the evenings there is a sudden flow of air, the evening sea breeze, from west-north-west on most days during the

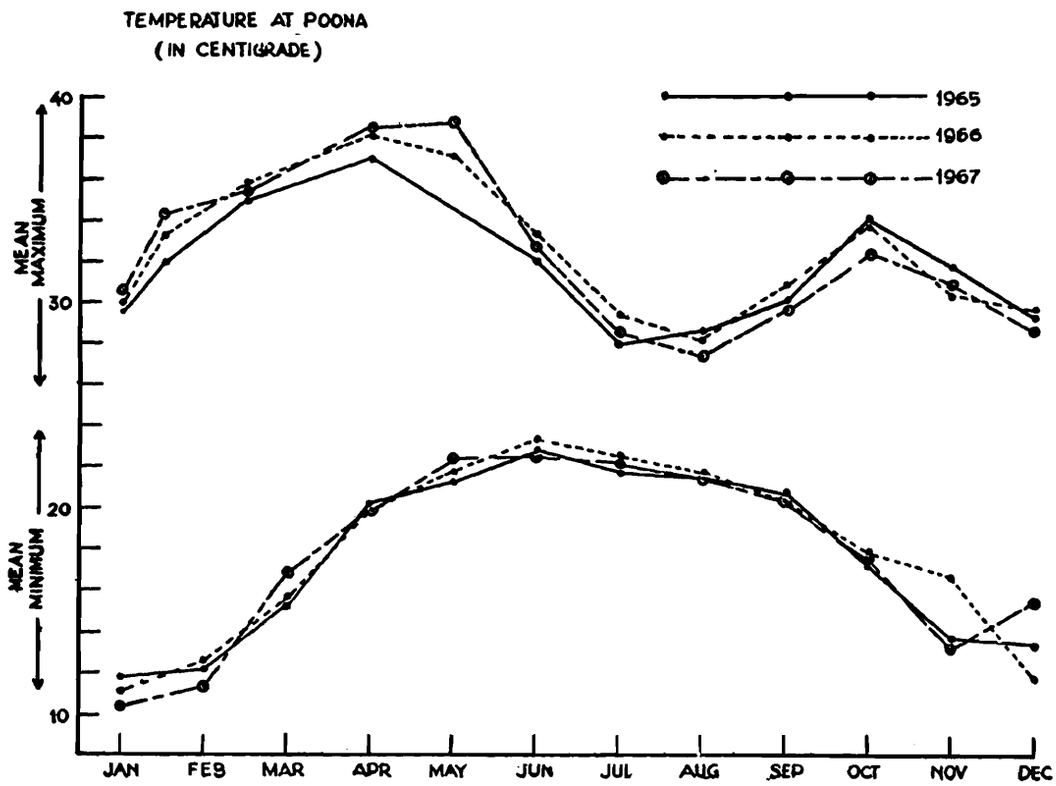
months of February, March, April and part of May, characterised by its greater gustiness, humidity and lower temperature.

Thunderstorms, dew and fog : Thunderstorms occur generally during the hot months of April and May, before the onset of monsoon in June and in September and October associated with the recession of the monsoon. Some of the thunderstorms in April and May are accompanied by squally winds, heavy rain and hail.

Morning fog occurs, though very infrequently, during October and in the winter season from November to January.

Morning dew appears in later part of October and lasts till the end of February. The difference between the percentages of relative humidity in the morning and evening goes on increasing from October. The wind speed during these months is relatively low, not more than 6.9 kilometres per hour. The range of temperature between the daily maximum and daily minimum is fairly high. All these contribute to the formation of dew.

Temperature : The monthly mean of daily minimum temperature ranges from 11.7°C. in December and January to 23.1°C. in June while the mean of daily maximum ranges from 27.6°C.



Text-fig. 2

in August to 38.3°C. in April. The mean temperature is the lowest in December. It rises steadily thereafter until the maximum is reached in April. With the onset of monsoons in June, day temperature suddenly falls and by August the mean maximum temperature touches its lowest value of the year. From September the temperature begins to rise again until the advent of the cold season in November. The daily range of temperature is least during the months of July and August, while during the cold season it is usually large, the maximum range being in February. The Meteorological Station at Poona has during the years 1920-1967 recorded a maximum temperature of 43.3°C. on 2nd May 1921 and a minimum of 1.7°C. on 17th January, 1935.

The monthly mean minimum and maximum temperature during the three breeding seasons (1965-1967) of the study period are detailed monthwise in Table 3 and 4, and Text-fig. 2.

TABLE III.—*Monthly mean minimum temperature (in °C) during the study period 1965-1967.*

Years	Months					
	January	February	March	April	May	June
1965	11.8	12.1	15.2	20.1	21.5	22.8
1966	11.2	12.5	15.7	20·0	21.8	23.3
1967	10.4	11 3	16.8	20.1	22.3	22.7
	July	August	September	October	November	December
1965	21.8	21.4	20.7	17.1	13.9	13·3
1966	22.5	21·6	20.5	17.9	16.7	11.9
1967	22.1	21.6	20.7	17.5	13.0	15 5

OBSERVATIONS ON THE BREEDING BEHAVIOUR

Observations made on the breeding habits of the House Crow, *Corvus splendens* Vieillot, Jungle Crow, *Corvus macrorhynchos* Wagler, and their brood parasite, the Indian Koel, *Eudynamya scolopacea* (Linnaeus) are recorded in the following pages.

TABLE IV.—*Monthly mean maximum temperature (in °C) during the study period 1965-1967.*

Years	Months					
	January	February	March	April	May	June
1965	29.7	31.9	35.0	37.3	37.2	32.2
1966	29.8	33.3	35.8	38.1	36.1	33.3
1967	30.2	34.2	35.2	38.3	38.9	32.7
	July	August	September	October	November	December
1965	28.1	28.5	30.2	34.4	31.8	29.3
1966	29.4	28.4	29.9	33.9	30.4	29.4
1967	28.4	27.1	28.8	32.2	30.9	28.6

1. **Corvus splendens** Vieillot

The Common Indian House Crow

Breeding Season

Number of seasons

The House Crow, *Corvus splendens* Vieillot, does not breed the year round at Poona. It has only a single breeding season of about 3½ months from late April to early August.

Duration

The breeding season commences by the middle of the hot season, *i.e.*, latter half of April when pair formation starts. Construction of nests is taken up by the beginning of May and and is at its peak in the last week of May. Some early breeders may lay by the middle of May but most birds do so from the end of May to early June. An occasional nest with young may be found as early as the first week of June but in most nests young emerge in the latter half of June and early July. By the end of July most nestlings have left the nest ; a few may, however, be met with as late as the beginning of August.

Mating

Pair formation

With the advent of the breeding season large flocks of the

House Crow, which habitually hang about near markets, rice and oil mills, municipal refuse dumping grounds, fruit gardens and cultivated fields, start breaking up, and the crowds at the roosts also start thinning out as a result of partners being sought out and courted. At this stage, late April to early May, if one happens to look for the House Crow, one finds it perching in pairs in shady trees or spots, resting after meals during the hottest part of the day. These pairs stick fairly close together throughout the day and keep very much to themselves except for short moments of excitement, generally in response to food-discovery or alarm calls by another member or members of the community, when they may join others of the community to do justice to the occasion.

Courtship behaviour

The pairs, once formed, are very much attached, the two partners feeding and resting together shunning the flocks and roosts of the community. The pair generally roosts together in trees and may often change the roosts till they have made up their mind about the nesting site. After the selection of the site the nesting tree serves as the roosting tree also.

While feeding very often the male would pass on a toothsome morsel to its mate who obliges by gracefully accepting it. While resting after feeding trips the two of a pair sit very close together often touching each other. As they sit side by side they often indulge in love play which may take one or the other of the following forms :

Head tickling : The male raises his beak over the head of the female and scratches the top of her head by repeated single strokes with the tip of the beak.

Billing : One of the pair brings its bills to its mate's, and gently touches it sometimes giving it a gentle rub.

Spooning : The male regurgitates and feeds the female.

Copulation

Although the most common bird everywhere, very rarely indeed does one observe the House Crow copulating. Copulation usually takes place in trees, sometimes on house tops or ground and occasionally even in the middle of a busy road. It may be

preceded by a mild love play in the form of head tickling, billing or spooning and a bit of tail waggling by the female, but as frequently as not it comes off without any preliminaries.

The male, having secured a hold on female's head with its beak mounts her back, and she in turn perches quietly with the neck drawn in and wings spread out a little. Balancing himself with his foot-and-beak hold the male brings his hind quarters down to affect a cloacal contact. The whole process takes hardly a few seconds. Sometimes, however, the male is not able to establish the contact at the first attempt, either because of losing his balance while lowering his hind quarters or owing to the movement of the female at the crucial moment under his weight. In such cases the male lowers his hind quarters a number of times against the female cloacal opening to affect copulation.

Copulation starts early at the stage of pair formation, is most frequent when the nest is under construction, and continues till the commencement of incubation, when it ceases to take place.

Number of mates

The House Crow is observed to be monogamous in the strictest sense of the word : only one female is courted by a single male. After the pair formation no overtures are made by either sex to other individuals (mated or unmated) of the community. During the short duration of their bond they behave like ideal partners always living together, loving and caring for each other.

Duration of Bond

To all appearances the House Crow pairs up only for a short duration of approximately 14 weeks in a year, *i.e.*, for a single breeding season. The pairs which emerge out of the flocks congregate back into flocks after the close of breeding season. Both the male and female of a pair which were banded for the study of the duration of bond in 1965 were observed paired up with different birds in 1966. It is, however, felt that the study, based on a single pair (two individuals) only is too inconclusive to prove or disprove anything.

Territory

Definition

Most birds during their breeding seasons resent intrusion by others of their own 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 variously defined by various workers. These definitions are discussed in detail in a later chapter (pp. 107-11). In the following pages, however, the term territory has been taken to mean a limited area around or adjacent to the nest, or proposed nesting site, any intrusion of which by others of the same sex and species in particular and other animals in general, is resented by the owner or owners of the nest.

Size

The House Crow reacts differently to different types of intruders. Their territorial limits vary from 1 metre to 100 metres and more depending upon the nature of the intruder, as detailed below :

i) *Others of the species* : The House Crow does not seem to mind other members of its species building their nests in the same tree or even on the same branch. As many as nine nests are sometimes located in a single large tree. These nests are, however, never placed very close together. There is always a distance of 2—3 metres in between the adjacent nests. The various nesting crows of a single nesting tree as well as some of the neighbouring tree or trees may rest together in its branches without inviting any hostility. But these resting or visiting crows always make it a point not to come close to another's nest. It would, therefore, appear that as far as others of the species are concerned the territory in the House Crow is limited to the immediate vicinity of the nest say 1 metre or so.

ii) *Harmless birds* : All small and harmless birds were observed to receive the same treatment as other individuals of the species. Their visits to or presence in the nesting tree or vicinity of the nest was not resented as

long as they remained about a metre away from the nest proper. They were welcome to use the nesting tree in any manner they thought fit, *i.e.*, for resting, feeding, etc. The harmless birds, especially the smaller ones are, however, very much afraid of the House Crow, the notorious destroyer of their eggs and young, and normally keep clear of its nesting tree. The House sparrow, *Passer domesticus* (Linnæus), is however, an exception to this rule. Not only does it venture right up to the nests (Plate VI, Fig. 1), but also perches on the rim of the nest and peeps inside it when unoccupied even when the owners are perching nearby.

iii) *The birds of prey* : The House Crow loaths, or perhaps fears, the presence of all birds of prey big and small, near its nest. No sooner does a bird of prey venture near say 30 metres or so of a nest or nesting tree than one or more of the owners of the nest make a dash at it and the intruder is given a hot chase till a safe distance of about 100 metres is put between the intruding marauder and the nest.

iv) *Koel* : The koel is hated most by the nesting crows. As soon as a koel is sighted in the vicinity of the nesting tree the nesting crows go after it in a red rage. The koel is chased till the pursuers lose all hope of catching up with it and punishing it. Some koels are unfortunate to get caught in the chase. Three such unfortunate ones were observed to escape with the loss of only a few feathers, but one was seen overpowered and mobbed to death by a number of crows. So greatly is the koel despised by the House Crow that it is not essential for the koel to venture near the nest to induce such a violent reaction. For a example, even when a koel's call is heard about 100 metres away from the nest, the House Crow will leave its proposed errand just to chase it away.

v) *Other animals :* All animals that climb or get into the nesting tree accidently or intentionally, are most unwelcome to the nesting House Crow, who individually as well as collectively protest against the intrusion. Such intruders, like an erring monkey, a hungry cat or snake,

or a visiting ornithologist, are not left in peace till they leave the tree and reach a place of shelter.

Defence

The House Crow appears to announce its territory by mere presence (Plate VI, Fig. 3) and defends it against all the above-mentioned kinds of intruders. The magnitude, ferocity and technique of territorial defence differ somewhat with different types of intruders.

Others of the species are always mindful of the privacy of the nesting birds. They never come within a metre or so of the nest. Only once did I observe a House Crow alighting within about 30 cm of the nest of another House Crow. One of the owners of the nest, the female who was incubating at that time, extended the neck and gave out a hoarse caw. This mild rebuke sent the intruding House Crow flying out of the nest tree.

Harmless birds (non-predators) too show a healthy respect of the nesting House Crow. They never venture within 1-2 metres of its nest. The erring ones are first warned by the crow present at or near the nest with a loud caw uttered with an extended neck. If this warning fails it is pounced upon by the defender. On no occasion are these non-predatory birds seen to wait till the attacking crow reaches them. They make themselves scarce the moment they see the owner launching itself at them.

All birds of prey excite the nesting House Crow very much. Every one of them who happens to fly past the nesting tree within a distance of about 30 metres is attacked and chased by the crows. The attacking House Crow gives out loud calls, perhaps to summon the help of the neighbours, as it launches itself after the intruders. The technique of attack is to get behind the intruder and peck at its back or tail if it can get close enough. The defending crow is always careful enough to keep out of reach of the beak and claws of the raptor. On the slightest turning movement of the intruding bird of prey the crow (or crows) turn tail (or scatter) momentarily only to resume the attack as soon as the raptor straightens. The intruder is chased a considerable distance away from the nest.

The koel has to violate the territory of the House Crow out of compulsion for relieving herself of its eggs. Whereas the attack on all other intruders is preceded by a warning, the attack on the koel is invariably launched surreptiously. The

technique of attack is the same as employed against the raptors, *i.e.*, to get behind and peck at any part of the koel's body within reach. The koel being a faster flier more often than not manages to shake off the pursuer after a while by putting a respectable distance between itself and the pursuers.

Other animals who chance to climb the nesting tree are always warned by a loud caw by the crow first to detect the intruder. This warning caw is soon taken up by other crows in the vicinity till the neighbourhood resounds with a chorus of loud caws from all directions. If the intruder proceeds further towards the nest some of the crows launch themselves into air, circle overhead defecating, cawing loudly and diving to peck at the head and back of the intruder. The defenders after a few sallies rest in a nearby branch while others of the congregation launch themselves in series of attacking sorties. The non-attackers encourage the attackers all the time with loud applause by cawing vigorously from convenient perches. Such attacks do not cease till the intruder leaves the tree and goes out of sight of the crows.

Nest Construction

Selection of site

Mating in the House Crow is indicative of the fact that it is going to start constructing the nest shortly. The first step towards the construction of a nest is the selection of a suitable site, of which there appears to be no dearth for the House Crow. A lot of hesitation is usually exhibited while the selection is being made. Many a time a site selected may turn out to be unsatisfactory on account of frequent visits of man, monkeys, small carnivores or raptors and may be deserted even when the nest is well under way. It has not been possible to ascertain beyond doubt as to which sex makes the final decision as regards the suitability of the site, as the birds could not be marked by coloured rings before the start of actual construction or occupation of the nest. Marking at roosts before the commencement of breeding season did not prove fruitful because hardly any of the marked birds could be located later in the study area, presumably because of their wide dispersal in the breeding season. However, I have reasons to believe that the female does have an important say in the matter. It is not an uncommon

sight in the breeding season to see a bird, stick in beak, moving from one tree to another, hesitant to put it down, being followed closely by another bird with or without a stick. On three such occasions I shot the leader in order to determine the sex and two of them turned out to be females.

Situation and location of nest

Normally a thin vertical fork near the top, or on one of the outermost branches of any larger tree, like *Dalbergia sissoo, Accacia arabica, Tamarindus indicus, Azadirachta indica* or *Ficus* sp. is a favourite site (Plate VII, Fig. 1). But in localities where larger trees are wanting or have already been occupied by others of its own species it does not hesitate to avail itself of other sites provided by forks in smaller trees, brackets and loops of telegraph and telephone poles and wires (Plate VI, Figs. 1 & 5), metal brackets of electric mains outside buildings and rarely, ledges and nooks of buildings.

Nesting material

After the site for the nest has been selected construction is taken up in right earnest. Both the birds go hunting for twigs and sticks together. Dry, usually thorny sticks are picked up from under the trees, hedges around the field and farms, and from the firewood-piles of poorer people. If fallen sticks are not readily available, twigs are wrenched off the trees. Occasionally metal strips and wires are also brought in for incorporation in the outer framework.

For the lining of the nest cavity softer, green vegetable material or fine pliable animal fibres are collected, evidently for their flexibility and manoeuvrability; dry material are also collected but are moistened in water before use. Grass roots, coconut and other vegetable fibres, grasses, human and animal hairs, feathers and rags are generally the material brought in for the purpose.

Mode of construction and share of sexes

After placing the first stick at the selected site both the partners go in search of more nesting material.

Having secured a stick the female returns directly to the

nesting site to fix it in position. The male usually accompanies her back even if he has not yet secured or found a stick of his own, though he usually manages to find one. The female first arranges her stick and later the one passed on to her by the male if he has brought one. The male does not do any actual building himself, but waits till she has fixed both the sticks to her satisfaction. Then they both fly away together in search of more material. Occasionally, when the male finds a twig before the female he may come and leave or place or arrange the stick in the nest pile. All such sticks are arranged in position by the female when she returns with her own sticks. The arrangement of a stick generally does not take more than a few seconds. However, when a difficult stage is reached, it may take a couple of minutes to adjust an awkward stick satisfactorily. As many as thirty sticks may be brought by both the partners and arranged in an hour during the peak of building activity.

In the earlier stages of construction the sticks, wires, etc., are arranged in a criss-cross fashion resulting in a circular platform 22-27 cm. in diameter. When the platform is three to four sticks thick, additional sticks are laid on it tangentially, converting it into a shallow cup 7-10 cm. deep and 5-8 cm. thick. The inside of this cup is lined with finer material mentioned above. The female applies her breast to smooth down the lining. The actual construction of the outer cup and the inner lining is done by the female alone, the male only helping her by bringing in suitable material. The female sits inside the nest and spends sometimes hours at a stretch fixing up the lining. During this time the male brings in the required material. When supplies from the male are inadequate, the female too goes in search of material.

Time required for completion of the nest

Both the male and female keep busy throughout the better part of the day bringing in material. There are interludes of course for meals, a little bit of love-play and love-making, and short rests in between material hunting trips. From observations made on 14 separate nesting pairs (Table 5) it was found that it took from seven to seventeen days to complete a nest with lining and all. Pairs who started construction early in the breeding season took relatively more time than those who started rather late.

TABLE V.—*Time required for nest construction.*

Sl. No. of the pair	Construction started on	Construction finished on	Time taken (in days)
3	6 June	15 June	9
4	8 June	18 June	10
7	9 June	16 June	7
11	27 April	14 May	17
16	18 May	1 June	14
19	24 April	10 May	16
21	21 May	2 June	12
24	2 June	12 June	10
25	28 April	13 May	15
26	2 May	18 May	16
31	12 May	26 May	14
37	21 April	8 May	17
40	4 May	19 May	15
44	15 May	27 May	12

The nest

The finished nest is generally speaking a large (25-30 cm.) shallow cup of sticks and twigs roughly put together and occasionally containing metal strips and wires ; the inner cavity is 12-15 cm. across and 7-10 cm. in depth, lined with roots, grass, vegetable fibres, animal hairs and other soft material already mentioned.

CLUTCH

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

The eggs are laid only when the nest is complete. The first egg is laid between the second and fifth days after the completion of nest (Table 6).

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

Sl. No. of the nest	Nest completed on	1st egg laid on	Time lapse (in days)
7	13 June	15 June	2
12	28 April	1 May	4
16	1 June	3 June	2
17	20 May	23 May	3
24	12 June	14 June	2
28	5 May	9 May	4
31	26 May	30 May	4
33	15 May	18 May	3
34	18 May	21 May	3
36	28 May	31 May	3
37	8 May	12 May	4
38	24 April	29 April	5
40	19 May	23 May	4
42	6 May	10 May	4
44	27 May	30 May	3
48	18 May	23 May	5
51	21 May	24 May	3
55	28 May	1 June	4
66	16 June	18 June	2

Laying pattern

Eggs are normally laid at 24-hour intervals. Occasionally (as in nest Nos. 12 and 44 in table 7), the time lapse between two successive eggs may be even 48 hours (Table 7).

TABLE VII.—*Laying pattern.*

	Nest Nos.						
	12	17	24	37	40	44	55
1st Egg laid on	1 May	23 May	13 June	12 May	23 May	10 May	1 June
2nd Egg laid on	2 May	24 May	15 June	13 May	24 May	11 May	2 June
3rd Egg laid on	3 May	25 May	16 June	14 May	25 May	13 May	3 June
4th Egg laid on	5 May	26 May	17 June	15 May	26 June	—	4 June
5th Egg laid on	—	27 May	—	16 May	27 May	—	5 June

Time of laying

Eggs are generally laid in the mornings between 7 and 11 hours. Occasionally, eggs are laid before or after this period too. Normally, however, the individual pattern of laying time is maintained. It was observed that nine females out of eleven observed, laid regularly between 7 and 11 hours. Of the remaining two, one laid before 7 hours, and the other after 19 hours (Table 8).

TABLE VIII.—*Time of laying.*

Egg found on visit at	Nest Nos.	Total nests
7.00 to 7.20 hours	37	1
10.30 to 11.00 hours	12, 17, 24, 33, 38, 42, 44, 48, 66.	9
19.30 to 7.00 hours	55	1

Clutch-size

Four or five eggs are normally laid but often three and rarely six eggs are also found. Out of 163 clutches recorded by

the author over a period of three years 60 clutches (36.8%) were of five eggs each, 58 clutches (35.6%) were of four eggs each, and 5 clutches (3.0%) were of six eggs each. The mean clutch-size for the years 1965, 1966 and 1967 was 4.1, 3.9 and 3.9 respectively, as may be seen from Tables 9-11.

Monthly mean clutch-size for all these years is given in Table 12.

TABLE IX.—*Clutch-size as observed in 1965 : April to July.*

Month	Number of clutches of				Mean clutch-size
	3	4	5	6	
April	—	2	2	—	4.5
May	5	10	18	1	4.4
June	11	5	3	1	3.7
July	2	—	2	—	4.1
Total	18	17	25	2	4.1
Percentage	29.1	27.4	40.3	3.0	

TABLE X.—*Clutch-size as observed in 1966 : April to July.*

Month	Number of clutches of				Mean Clutch-size
	3	4	5	6	
April	1	1	—	—	3.5
May	3	13	9	1	4.3
June	8	7	10	1	4.1
July	2	1	1	—	3.7
Total	14	22	20	2	3.9
Percentage	24.1	38.2	34.5	3.4	

TABLE XI.—*Clutch-size as observed in 1967 : April to July.*

Month	Number of clutches of				Mean Clutch-size
	3	4	5	6	
April	1	—	1	—	4.0
May	1	9	6	1	4.4
June	5	10	8	—	4.1
July	1	—	—	—	3.0
Total	8	19	15	1	3.9
Percentage	18.6	44.0	35.0	2.3	

TABLE XII.—*Monthly mean clutch-size.*

Year	Month	Number of clutches	Mean clutch-size	Mean clutch-size for the year
1965	April	4	4.5	4.1
	May	34	4.4	
	June	20	3.7	
	July	4	4.0	
1966	April	2	3.5	
	May	26	4.3	3.9
	June	26	4.1	
	July	4	3.7	
1967	April	2	4.0	
	May	17	4.4	3.9
	June	23	4.1	
	July	1	3.0	

Seasonal variation

As may be seen from the above tables, the larger clutches (of five) were laid more frequently in the first half of the breeding season. This highlights an increase in the average clutch-size and also in the number of clutches to its maximum in the first half, reaching its peak by the end 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 sinks down to its lowest by early July.

It was also observed that in the years in which the breeding season started early (*e.g.*, 1965) the average clutch-size was larger (4.1) than (3.9) in the ones in which it started late (*e.g.*, 1966, 1967).

EGGS

Shape

The eggs vary a good deal in shape, size, colour and markings. Typically the egg is ovoid in which the end is large and the other pointed. However, pyriform, elongate and globular varieties are also met with occasionally.

Colour and markings

The shell is hard, fine in texture and fairly glossy. The ground colour is always one of the many shades of bluish green (Plate VII, Fig. 2). The markings are in the form of blotches, specks and streaks of any of the many shades of dull reddish brown, sepia, grey or fleshy. The shape and intensity of blotches, specks and streaks vary widely in various eggs and clutches and also in various parts of the same egg, markedly so near the ends (Plate VIII, Fig. 5).

Size

A large number of eggs from nests under observation were measured and weighed. On the average the eggs measured 38.5 × 26.1 mm.; with 44.0 × 24.0 mm. to 38.0 × 28.0 mm. as the maximum, and 32.0 × 25.0 mm. to 44.0 × 24.0 mm. as the minimum (Table 13).

TABLE XIII.—*Size of the eggs* (*Corvus splendens* Vieillot)

Length in millimeters.

Year	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5	40.0	40.5	41.0	41.5	42.0	42.5	43.0	43.5	44.0	44.5	Breadth in mm.
1965	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29.0
	—	—	—	—	—	1	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28.5
	—	—	—	—	1	1	1	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	28.0
	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	27.5
	—	—	—	1	1	1	1	1	1	1	—	1	—	1	1	—	1	1	—	—	1	—	—	—	—	—	27.0
	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	1	—	—	—	—	—	1	—	—	—	—	26.5
	—	—	—	—	—	—	—	—	—	—	1	—	1	—	1	—	—	1	—	—	1	—	1	—	—	—	26.0
	—	—	—	—	—	—	—	1	—	—	1	1	—	—	—	1	—	—	—	—	—	1	—	—	—	—	25.5
	—	1	—	—	—	—	—	1	—	—	1	1	1	—	—	—	—	1	—	—	1	—	—	—	—	—	25.0
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	1	—	—	—	1	—	—	24.5
	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	1	—	1	—	—	—	2	—	24.0
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	23.5
1966	—	—	—	—	—	—	1	—	1	—	1	2	1	1	—	—	—	—	—	—	—	—	—	—	—	—	28.0
	—	—	—	—	—	—	1	—	1	—	—	1	1	1	—	1	—	1	—	—	1	—	—	—	—	—	27.5
	—	—	—	—	—	1	—	1	—	—	—	1	1	1	1	1	1	—	1	—	1	—	—	—	—	—	27.0
	—	—	—	—	—	—	1	—	1	1	—	1	1	1	1	1	1	1	—	—	—	—	—	—	—	—	26.5
	—	—	—	1	—	1	—	1	—	1	1	—	1	1	1	1	1	1	1	1	1	—	1	—	—	—	26.0
	—	—	—	—	—	—	—	—	1	1	1	1	1	1	1	1	—	1	1	—	1	1	—	—	—	—	25.5
	1	—	—	—	1	—	1	—	1	1	—	1	1	—	1	1	1	—	1	1	1	1	1	—	—	—	25.0
	—	—	—	—	—	—	—	—	—	1	1	1	—	—	1	—	—	1	—	1	—	—	—	—	—	—	24.5
	—	—	—	—	—	—	—	—	—	—	1	1	1	—	1	1	1	—	1		—	—	—	—	—	—	24.0
	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	23.5
1967	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	28.5
	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	28.0
	—	—	1	—	—	—	—	—	1	—	1	1	—	1	1	1	1	1	—	—	—	—	—	—	—	—	27.5
	—	—	—	—	—	1	1	—	—	—	—	1	1	—	1	1	1	—	1	—	—	—	—	—	—	—	27.0
	—	—	—	—	—	—	—	1	—	1	—	1	1	1	1	1	1	1	1	—	—	—	1	—	—	—	26.5
	—	—	—	—	—	—	1	—	1	1	—	—	1	1	1	1	1	1	—	1	—	1	—	—	—	—	26.0
	—	—	—	—	—	—	—	1	—	—	—	—	—	1	1	1	—	1	—	1	—	1	—	—	—	—	25.5
	1	—	—	—	—	—	—	—	1	—	—	1	—	—	1	—	1	—	1	—	—	—	1	—	—	—	25.0
	—	—	—	—	—	1	—	—	—	—	1	—	—	1	—	1	—	—	—	—	—	—	—	—	—	1	24.5
	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	24.0

Average of 57 eggs : 38.5×26.1 mm.

Average of 94 eggs : 38.5×25.9 mm.

Average of 66 eggs : 38.6×26.2 mm.

Weight

On an average the eggs weighed 11.65 grams each (maximum 14.0 grams, minimum 9.5 grams). The average weight was lowest (11.15 grams) in 1966 and highest (11.30 grams) in 1967 (Table 14).

TABLE XIV.—*Weights of eggs of the House Crow during 1965 to 1967.*

Year	No. of eggs	Weight in grams 9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	Mean
1965	57	—	14	7	8	5	4	5	8	6	—	11.48
1966	93	1	18	12	14	7	8	10	12	11	—	11.56
1967	66	—	8	6	5	6	14	10	8	7	2	11.92
Total	216	1	40	25	27	18	26	25	28	24	2	11.65

A detailed study of comparative weights of successive eggs was undertaken in a limited number of twelve 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 15).

TABLE XV.—*Comparative weights of fresh successive eggs in 12 clutches.*

S. No. of clutch	Egg No.	Weight at laying (in grams)	Average weight per clutch
I	1	10.0	11.5
	2	11.5	
	3	11.0	
	4	12.0	
	5	13.0	
II	1	11.0	12.25
	2	12.5	
	3	13.5	
	4	13.0	
III	1	9.5	10.0
	2	10.0	
	3	10.0	
	4	10.5	
	5	10.0	
IV	1	11.0	11.8
	2	11.5	
	3	11.5	
	4	12.0	
	5	13.0	
V	1	10.5	11.37
	2	11.0	
	3	12.5	
	4	12.5	
VI	1	11.0	12.5
	2	12.5	
	3	12.5	
	4	13.5	
	5	13.0	
VII	1	10.5	11.0
	2	11.0	
	3	11.0	
VIII	1	12.0	12.9
	2	12.5	
	3	12.5	
	4	13.5	
	5	14.0	
IX	1	11.5	12.0
	2	12.0	
	3	12.0	
	4	12.5	
X	1	11.0	11.25
	2	11.0	
	3	11.5	
	4	11.5	
XI	1	12.0	12.3
	2	12.5	
	3	12.5	
	4	12.0	
	5	12.5	
XII	1	10.5	11.6
	2	11.0	
	3	12.0	
	4	11.5	
	5	13.0	

Determinate layer

If one or more eggs are removed from a completed clutch the House Crow does not lay any more egg. Neither does it cease to lay more eggs if the clutch is artificially completed by adding eggs.

INCUBATION

Definition

To incubate is to apply heat to the eggs for the development of the embryo. The House Crow does it, like most other birds, by sitting on them.

Commencement

As soon as the first egg is laid the House Crow starts sitting on it, that is, it does not wait till the complete clutch is laid.

Share of sexes

The incubation, for the most part, is done by the female. The male relieves her at intervals during the day when she goes out for food and much needed outings. During this relief period the male may sit on the eggs or stay on or near the nest as if on guard duty (Plate VI, Fig. 5). At night the female alone sits in the nest. The details of incubational reliefs as observed in two nests with marked birds from 5.30 to 20 hours are detailed below. On the average the share of the male in incubation works out roughly to 4 hours 36 minutes a day, whereas that of the female to 18 hours 38 minutes.

Nest No. 39, Date 16-5-1966.

5.50 hours	Female leaves the nest with the first light of dawn. Male appears and perches near the nest.
6.15 „	Male settles in the nest.
7.15 „	Female arrives. Male leaves the nest.
7.16 „	Female settles in the nest.
11.30 „	Male arrives. Female leaves the nest, sits next to the male on the edge of the nest.
11.33 „	Female takes off. Male settles in the nest.
12.38 „	Female arrives and perches near the nest, male keeps on sitting in the nest.
12.40 „	Male leaves the nest and joins the female perched a little away from the nest.

12.45	„	Female occupies the nest. The male takes off.
17.00	„	Male arrives and takes over from the female.
19.00	„	Female arrives. Male leaves the nest to join her in a branch nearby.
19.30	„	Female occupies and settles in the nest.
20.00	„	Female still sitting in the nest.

Nest No. 57, date 6-6-1966.

5.45	hours	Female leaves the nests and sits in a branch nearby.
6.00	„	Male arrives in the nesting tree, indulges in a little love-play.
6.20	„	Female takes off. Male occupies the nest.
7.12	„	Female is back. Male leaves the nest immediately. Female settles in the nest.
11.02	„	Male arrives. Female keeps sitting. Male sits near the edge of the nest.
11.13	„	Male moves away from the nest. Female still in occupation.
11.45	„	Female leaves the nest, joins the male in a neighbouring tree.
11.48	„	Male occupies the nest, female keeps perching in the nesting tree.
12.10	„	Female takes off.
14.46	„	Female arrives. Male takes off. Female moves into the nest.
17.15	„	Male arrives and perches near the nest. Female leaves the nest.
17.17	„	Male occupies the nest.
18.40	„	Female arrives. Male leaves the nest and joins her in a branch nearby.
19.24	„	Male takes off.
19.28	„	Female settles in the nest.
20.00	„	Female sitting in the nest.

Reaction to alterations and substitution of nest-contents during incubation

It will be interesting to record here the reaction of the incubating birds to strange eggs and foreign objects placed in the nest. Usually the nest is never left unattended. One of the birds incubates or mounts guard when the other is away and does not ordinarily leave the nest till the partner relieves him or her. But the sight of a koel in the neighbourhood or of a man climbing the tree on which the nest is located or another nesting tree in the vicinity is too much for the crow to endure. Losing all self-control it launches in sudden fury an attack all by itself or joins the melee of the brotherhood for an attack on the intruder, forgetting for a while its own eggs. It is during such unguarded moments of extreme excitement that it is sometimes decieved by a female koel or an experimenting ornithologist. The koel seizes the opportunity to place its eggs in the

nest and the ornithologist replaces the crow's eggs by other object.

Intelligent as the bird is, it is hard to believe that it does not notice the change when it returns. But it may react differently to the visit of the two abovementioned intruders. After having noticed the man's approach, and then the change in the contents of the nest, it may attribute the change to the visit of the man and may abandon the nest with its contents. But such desertions are very rare ; in my experience they are not more than 5 per cent, presumably because the crow is not much afraid of man.

If the nest has been robbed completely it is sure to be deserted. If only a part of the contents has been removed or replaced apparently no great notice is taken no matter how strikingly different the replacement may be, for the nest is not deserted. On several occasions I removed one or two of its eggs and replaced them after painting them scarlet and brown with transparent photographic dyes, and they were accepted coolly. Thrice a House Crow accepted eggs of Jungle Crow, twice of a Common Myna and once of a Paddy Bird added by ones and twos to its own clutch. It refused to incubate and, in fact, devoured a full clutch of the Myna's eggs kept as replacement, as well as a clutch of eggs of the Black Drongo, but readily accepted a Jungle Crow's clutch in replacement. It appears that this species accepts strange eggs and foreign objects if they resemble its own clutch or if one or more of its own clutch or if one or more of its own eggs are left in the nest along with the replacements.

No additional eggs are laid to replenish partial loss of clutches either by accident or by experimental removal.

Incubation period

After a period of incubation the eggs hatch out generally in the order in which they are laid. The time lag between the laying of the last egg and its hatching has been reckoned here as the incubation period. Out of the 21 nests observed over a period of three years for the determination of the incubation period, in 14 nests the last egg hatched out after 16 days of incubation, in three nests after 17 days, in two nests after 15 days and in another two the last egg failed to hatch (Table 16).

TABLE XVI.—*Incubation period.*

Year	Nest No.	Last egg laid on	Last egg hatched on	Incubation period (in days)
1965	26	12 May	28 May	16
	28	14 May	30 May	16
	29	20 May	6 June	17
	31	2 June	18 June	16
	34	25 May	10 June	16
	36	3 June	18 June	15
	37	16 May	1 June	16
1966	39	4 May	20 May	16
	41	7 May	24 May	17
	44	13 May	29 May	16
	48	3 June	19 June	16
	50	1 June	—	Did not hatch
	53	30 May	15 June	16
	57	4 June	20 June	16
	61	6 June	22 June	16
1967	69	10 May	26 May	16
	71	13 May	28 May	15
	73	17 May	2 June	16
	79	27 May	13 June	17
	80	4 June	—	Did not hatch
	84	5 June	21 June	16

Hatching pattern and success

The young hatch out, one after the other, at an interval of 22 to 26 hours, more or less in the order in which the eggs are laid. In 88 clutches observed during the course of the study, only in seven clutches one or two eggs failed to hatch. In these

cases it was observed that it was the last egg and/or the last but one which failed to hatch (Table 17).

TABLE XVII.—*Eggs that did not hatch.*

Nest No.	No. of egg in the clutch	Egg No. that did not hatch
27	6	V & VI
33	4	IV
42	5	V
50	5	IV
58	5	V
72	3	III
80	4	IV

During this study I came across two complete clutches (One of five and other of four eggs) which failed to hatch. The birds kept on incubating these clutches for 30 days in one and 31 days in the other before giving up and deserting the nest finally.

On two occasions (Lamba, 1963a : 128) I collected House Crows' nests with eggs for study for their ectoparasites, which according to my previous observations should have been incubated for more than a week. To my surprise they failed to show any signs of developing embryo on being opened ; evidently the clutches were infertile.

The hatching success in the House Crow was found to be very high. Out of 678 eggs laid only 44 did not hatch out. The hatching success, therefore, works out as 93.51% (Table 18).

TABLE XVIII.—*Hatching success.*

Year	Total eggs laid	Eggs that did not hatch	Percentage of unhatched eggs	Eggs that hatched	Percentage of hatched eggs
1965	226	14	6.2	212	93.8
1966	258	17	6.6	241	93.4
1967	194	13	6.7	181	93.3
Total	678	44	6.4%	634	93.51%

The unhatched eggs were cleared by the parents three to five days after the hatching of the last chick.

NEST LIFE

Physical features and weight at hatching

The hatchings are nidicolous. The newly hatched young are fleshy pink in colour. The beak and claws are soft except the tips that are hard and are of the general colour of the body. The egg-tooth is not quite discernible. The mouth cavity is reddish in colour without any directive marks. The abdominal wall is almost transparent through which remnants of the yolk sac are still visible. The eyes are closed. There are very faint traces of whitish nestling down restricted to the dorsal and pelvic feather tracts. The freshly hatched fledglings are unable to stand or sit up on their feet (Plate VII, Fig. 4). They are, however, capable of raising their necks and gape for food.

The weight of the chick at hatching is slightly less (0.3 to 0.5 grams) than that of the egg at the time of laying.

Brooding, care and feeding of the young

The freshly hatched young are kept warm during the night by the brooding mother and protected from hot sun during the day by both the parents who take turns at brooding. The brooding by day stops after the fourth to sixth day of the emergence of the first hatchling, but brooding at night by the female continues till the chicks are partially fledged, that is, when they are about 14-17 days old.

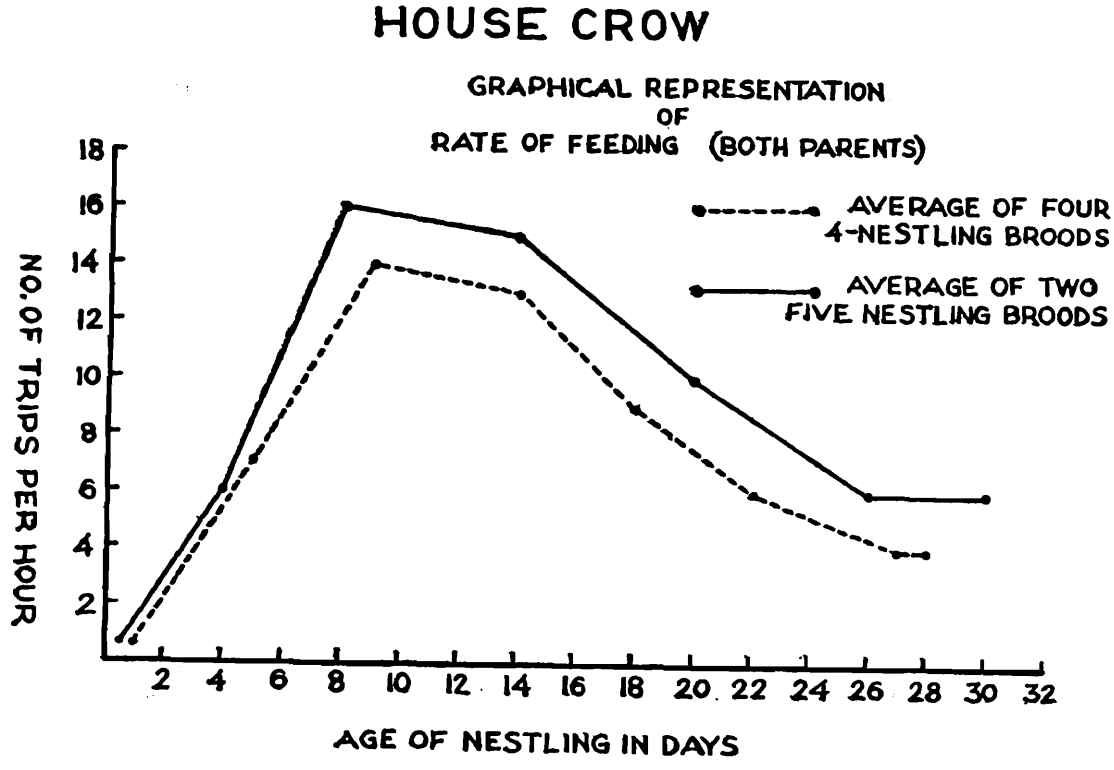
The nestlings are never left unguarded. One of the parents is always around, especially during the early days, to guard them from predators, to warn them of any approaching danger or to protect them from hot sun and rains.

The first serious attempts to feed the young are made when they are about 24 hours old. They are then fed on soft, regurgitated food which is pourd down their gullets by the parents. Both parents bring food for and feed the young (Plate VI, Fig. 2) the female exerting a little more than the male.

Food and rate of feeding

The feeding activity starts in earnest from the second day

of the first hatching. It goes on increasing as more and more nestlings hatch out and join in the demand for food. The parents make hurried trips to grab something passable. The peak of this acticity reaches by the eighth day and is, more or less, maintained for three to six days (Text-fig. 3). During this peak period as many as ten trips an hour by the mother were clocked on a number of occasions, and this figure rose to 16 for both the parents together. 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.



Text-fig. 3.

This tends to reduce slightly the number of feeding trips by the parents. When the chicks are about 14-17 days old they may be fed, or they accept food, three to four times in an hour at the maximum. This rate of feeding declines gradually till the nestlings are about 21 days old, when rate of feeding falls to only once or twice an hour till the fledglings leave the nest.

Fledglings 14-21 days old demand food on the arrival of the parent at nest by spreading their wings, shaking them slightly and gaping at the same time.

The solids on which the chicks are fed include everything a man would eat and many things he would not. Generally the bill of fare includes pieces of chapatties, boiled rice, cereals

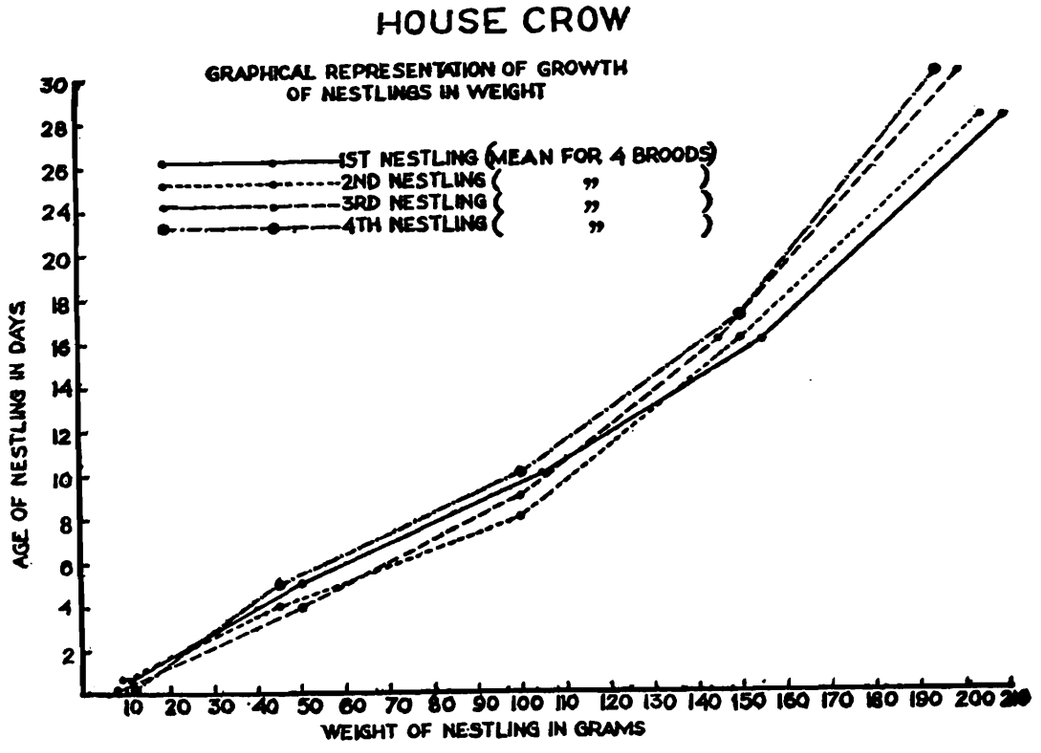
and whole grain, bits of vegetables and fruit, pieces of flesh, offal and carrion, catterpillars and whole soft-bodied insects.

Nest sanitation

The House Crow keeps the nest clean and tidy. After the emergence of the chick, the egg shell is eaten away 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 task of nest sanitation. As the young grow in age and acquire mobility they start elevating their hind quarters at the time of ejection over the rim of the nest and the faecal matter drops under the nest. This participation by youngsters in the nest sanitation normally starts when they are about 17 days old and continues till the time of their departure.

Growth of the nestling

As has been already stated the weight of the nestling at hatching is slightly (0.3 to 0.5 grams) less than the egg from which it emerges. As very little feeding is done during the first 24 hours the nestling does not gain more than 2 to 5 grams in



Text-fig. 4.

weight during this period. With the intensification of feeding from the second day the gain in weight increases rapidly varying between 8 and 15 grams a day till the nestling is about 8 to 10 days old when it reaches about 100 grams. In the second week, especially near the end, the rate of growth in weight is somewhat arrested, varying between 6 and 12 grams a day. In the third week the rate of increase in weight is reduced to 30 to 38 grams for the whole week and during the fourth week the gain in body weight is at its lowest, *i.e.*, 23 to 30 grams. At the end of the fourth week the nestling weighs on the average a little more than 200 grams (Text-fig. 4).

The eldest fledgling generally reaches its 100 grams in weight in about 8 days while the youngest does so in about 10 days time. The youngest, however, catches up by the end of the fourth week (Table 19).

TABLE XIX.—*Weight of young in nest.*

Age in days	Eldest		Youngest	
	No. of cases	Average wt. in grams	No. of cases	Average wt. in grams
0.25	21	11.81	21	11.65
1	21	15.23	21	13.85
2	21	27.37	21	24.71
3	21	41.81	21	37.37
4	21	55.74	21	46.24
5	21	63.24	21	57.97
6	21	72.11	21	60.65
7	21	86.69	21	68.19
8	21	99.93	21	79.12
9	21	109.00	21	89.82
10	21	118.63	21	100.13
11	17	124.94	18	111.51
12	17	133.67	17	123.86
13	14	139.70	16	134.10
14	13	148.09	14	142.60
21	8	178.21	8	176.77
28	5	201.80	5	200.97

I have selected the 'eldest' and the 'youngest' nestlings for this comparative study instead of 'first' and 'last' or in fact all the nestlings of a brood for the following reasons :—

i) The last nestling (sometimes even last but one also) often died during the first week.

ii) As the crows gathered in large numbers to torment the climber who brought the nestlings down to the vehicle for weighing it was considered advisable to handle the minimum number of nestlings in the shortest possible time.

Very few nestlings of three to four weeks age group could be weighed because it became exceedingly difficult to catch them due to their habit of climbing into adjacent branches on the approach of the climber.

Donning of feathers

The nestling as it emerges from the egg is naked except for very faint traces of down on the pelvic and dorsal feather tracts, and filoplumes in place of remiges and rectrices. The following dorsal and ventral pterylae become distinct when the nestling is about 72 hours old.

Dorsal : Spinal (dorsal and pelvic only), humeral, femoral, crural and caudal.

Ventral : Sternal, axillar and abdominal, (Text-figs. 7-9).

The contour feathers (teleoptiles) are still stub-like structure under the semi-transparent skin at this stage.

These stubs elongate and pierce the skin when the fledgling is about 6 days old (Plate VI, Fig. 4). At about the same time the capital (dorsal) and malar and cervical (ventral) tracts become distinct though the sheaths of teleoptiles are still under the skin in these regions. The remiges and rectrices too pierce the skin at about the same time in the form of thin needle-like structures.

The rate of growth of remiges is many times more than the other feathers, including the rectrices. The points of these elongate needles burst into a tuft of feathers on or about the 9th day when the primaries are about 18 to 20 mm. long. The rectrices by this time are still 4-6 mm. long though they too bloom simultaneously. At this stage, with elongate shafts and tuft of hairs at the distal end, they resemble miniature artists' brushes arranged in rows. The tuft gradually elongates into rachis and vane while the shaft ultimately forms the calamus.

There is a gradual growth of all these feathers in size and length and also in density in the case of contour feathers as more and more feathers sprout on various pterylae. By the end of the second week the whole body of the nestling is thinly covered with feathers except for a patch on the abdomen. Along with the gradual growth of the nestling in size and weight the body feathers, remiges and rectrices too grow in size. By the time the fledgling is about four week old it is fully fledged.

Behaviour of nestlings

During the early days before the eyes of the nestling are open, if the rim of the nest or a part of its body is touched or a noise is made near the nest, the nestling reacts by raising its neck and gaping for food. This food response is continued even beyond the 4th or 5th day when the eyes open. After their eyes are completely open by the 8th or 9th day, the nestling start making distinction between the visit of the parent and the visit of human intruder. While the same reaction of begging for food continues in response to a visit of the former a visit of the latter is reacted to by a show of fear. The fear-reaction is expressed by crouching low in the bottom of the nest and tightly clinging to the nest-lining. Similar fear-reaction is also exhibited at the warning call of the parents, when larger birds of prey are around. If they are picked up by hand, they may even defecate.

By the end of the third week at the approach of a human climber the nestlings often evade capture by leaving the nest and climbing quickly on adjacent branches. During the fourth week, especialy towards the end, they often accomplish this by flying to branches nearby or to a neighbouring tree. While doing so they often misjudge their capability and end up on the ground.

When about four weeks old the fledglings practise occasionally 'dry flights' by just flapping their wings while perching, and even undertake short flights to nearby branches.

Length of nestling period

By the end of fourth week most young ones leave the nest. A few weaker ones (usually the last to hatch) may however. stay on till the middle of the fifth week (Table 20).

TABLE XX—*Length of nestling period.*

Year	Nest No.	Last chick hatched on	Last chick left on	Period (in days)
1965	26	28 May	26 June	29
	31	18 June	15 July	27
	34	10 June	10 July	30
	37	1 June	3 July	32
1966	41	24 May	21 June	28
	48	19 June	15 July	26
	53	15 June	15 July	30
	57	20 June	18 July	28
1967	69	26 May	21 June	26
	73	2 June	30 June	28
	79	13 June	10 July	27
	80	4 June	5 July	31
			Average	28.5

After leaving the nest the young birds stay around in the branches of the nesting tree where they are fed by the parents. Later they start following the parents and stay close to them for a couple of weeks, always cawing for food as soon as the parents pick up any. By remaining in company of the parents the young presumably learn to fend for themselves before finally parting company.

Nestling mortality

Just as all the eggs that are laid do not hatch, all the young that hatch out do not live to leave the nest, as may be seen from Table 21. During this study it was observed that out of 634 nestlings that hatched out in 163 nests as many as 263 died in the nest. The mortality, therefore, works out roughly as 41.5%.

TABLE XXI.—*Nestling mortality.*

Year	No. of nests observed	No. of eggs hatched	No. of fledgling that flew out of the nest	No. of fledgling that died	Percentage
1965	62	245	147	98	40.0
1966	58	218	129	89	40.8
1967	43	171	95	76	40.4
Total	163	634	371	263	41.4

The majority of deaths occur in the first week. Most deaths among the young House Crows are due to want of food which is largely precipitated and accentuated by the young parasitic koels, who hatch out earlier than their foster brethren and devour a major portion of the food brought by the parents. The death is rarely due to a chance fall from the nest or as a result of some marauder's attack. Although the parent birds keep bringing in food from dawn till dusk they cannot usually meet the full demand of a clutch of five, and sometimes even of four nestlings who, for the first few (5-6) days consume more than their own weight (at hatching) of food. In case, however, there is an abundance of food in the locality, they do get round to the feeding of all the four or five of the clutch satisfactorily. 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 billfull of food is 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, until the food it has brought is finished, or the chick is unable to swallow any more. In such cases what remains is pushed down another throat. This is repeated at every visit of the parent. The young which are not fed until their stronger or foster brethren have received all they can hold, start losing ground 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 attempt to feed them. The weakest thus

go to the wall. The dead are thrown out by the parents without the slightest concern. Most such deaths occur during the first week and some early during the second week.

Nesting success

As already indicated the nesting success in the House Crow depends on many factors, the most important ones being the the amount of food available for the young at the nesting stage, fertility of the eggs laid, interference by parasites (koel) and predators (including man). A few deaths on account of diseases cannot be ruled out either.

In the present study a total of 678 eggs were laid in 163 nests. A total of 371 young (excluding the koel nestlings) left the nest (Table 22). The nesting success, therefore, comes to 54.7 per cent.

TABLE XXII.—*Nesting success.*

Year	No. of nests observed	No. of eggs laid	No. of fledglings that flew out of the nest	Percentage
1965	62	258	147	57.0
1966	58	240	119	49.5
1967	43	180	95	52.8
3	163	678	361	54.7

2. **Corvus macrorhynchos** Wagler, The Jungle Crow
Breeding Season

Number of seasons

At Poona the Jungle Crow breeds only once a year, although it has been recorded to breed twice (Hume, 1873 : 411; 1889 : 4; Whistler, 1928 : 4; Baker, 1932 : 7-9) a year in some parts of India. The single breeding season observed at Poona is of about four months duration, that is, from the end of February to the end of June.

Duration

The breeding season commences by the end of February, that is, a little before the hot season begins, when pair formation starts. Construction of nests is taken up early in March and is at its peak towards the end of the month. Although occasional eggs may be met with as early as middle of March or as late as middle of May, majority of the birds lay in April. Most nestlings hatch out from the end of April to the middle of May. By the end of May the nestings start leaving the nest. In June the nests become empty, rather rapidly as the month advances and by the end of June rarely an active nest is met with.

Mating

Pair formation

By the end of February or beginning of March, small flocks of the Jungle Crow which habitually feed in roadside Ficus trees when in fruit, scrub jungles around inhabited areas, cultivated fields and often in the suburbs in company with the House Crow, tend to disintegrate into pairs. The partners are sought out and courted. Many a time early in the breeding season I have seen parties of three Jungle Crows moving around with two of its members starting a fight without any apparent provocation. One moment they are perching in a branch or on a fence, and the next moment they are on the ground lying on their sides holding each other with claws and beaks, manoeuvering for an advantageous position or hold with their wings against the ground. The third member of the party keeps in its perched position watching the proceedings and cawing occasionally. Only once was I able to shoot such a party to ascertain their sex. Both of the fighting birds turned out to be males, while the spectator a female. I am inclined to believe that these fights are a part of the mode of pair formation particularly for the possession of the female, the victorious male ultimately pairing off with the female.

Courtship behaviour

The pairs when formed separate out from the flocks or

community gathering. They keep fairly close together even while feeding or resting. While feeding the male may often transfer a bit of delicacy he has picked up to his mate. While resting after feeding or during the hottest hours of the day, the pair perch close to each other and indulge in love play. The love play may take any of the following forms :

Head-tickling : One of the pair raises its beak over the head of the other and scratches the top of the head with the tip of its beak by repeated single strokes of its beak.

Billing : One of the pair stretches its neck so that its beak touches that of its mate, or rubs gently against it.

Spooning : The male regurgitates and feeds the female.

Copulation

The love play often ends up in copulation. The copulation usually takes place in branches of trees, sometimes on house tops or on the ground, and occasionally in the middle of a road. Love play is not an essential prerequisite to the act. The copulation is performed in the usual bird fashion, and no particular time of the day was observed to be preferred for the purpose. The sexual intercourse is most frequent while the nest is being constructed. It ceases when incubation starts.

Number of mates

The Jungle Crow, like its cousin the House Crow, is strictly monogamous. Only one female is courted by a single male. After the pair formation no attempt to woo another individual of the species, mated or unmated, is made by any of the pair. During the short duration of their bond they behave like ideal partners, always loving and caring for each other.

Duration of bond

The Jungle Crow pairs up only for a short duration of approximately four months in a year, *i.e.*, for a single breeding season. The pairs that emerge out of flocks at the beginning of the breeding season congregate back into flocks after the breeding season is over. In the non-breeding season no distinct pairs are observed.

Territory

Size

The Jungle Crow reacts differently to different types of intruders, resenting the intrusion of each type in a different manner. Their territorial limits varied from 0.5 metre to 200 metres depending upon the nature of the intruder as detailed below :—

i) *Others of the species :* The Jungle Crow exhibits a very marked respect for the privacy of others of the species. No two nests of the Jungle Crow are constructed on the same tree, not even on two adjacent trees unless they are about 100 metres apart. Once a pair of the Jungle Crow starts building their nest, others of the species dutifully avoid the vicinity ; they never even alight on a nesting tree unless it happens to be their own.

ii) *Harmless birds :* All harmless small birds, like sparrows, bulbuls, flycatchers, sunbirds, etc. are well-tolerated. They are welcome to make use of the nesting tree in any manner they think fit as long as they keep about 0.5 metre away from the nest proper. Some curious ones of these birds may even venture to perch on the edge of the nest and peep inside while the owners are temporarily absent. Normally these harmless birds are afraid of approaching the nest proper while the owners (Jungle Crow) are around.

iii) *The Koel :* The koel, although it is known to parasitise the brood of the Jungle Crow, is not at all unwelcome to the nesting tree. Many a time have I seen koels (female as well as male ones) resting in the branches of large Banyan trees in which a pair of Jungle Crows was nesting at that time. The Jungle Crow treats the koel in the same manner as it does the harmless birds. I have not myself seen any Jungle Crow attacking the koels like the House Crow does, nor have I come across any such instance in the published literature.

iv) *The birds of prey :* The presence of all birds of prey, big and small, in the vicinity of the nesting tree is

highly resented. Any hawk, falcon or kite, which happens to fly by is immediately set upon by both owners of the nest and is not left in peace till it puts about 200 metres between itself and their nest. Any of them found perching within 200 metres or so of the nest is attacked and made to vacate the area.

v) *All other animals :* (including man) that climb or get into the nesting tree accidently or intentionally are immediately attacked, more and more violently as they get nearer the nest.

Defence

The Jungle Crow defends its territory against all the above-mentioned intruders.

Others of the species never come near the nest or nesting tree. The harmless birds and koel too never dare to come too close to the nest proper while the owners were around. Any of these intruders who came too near the nest was threatened by a single caw emitted by the Jungle Crow with an extended neck.

All birds of prey were chased and dived at. The back and tail of the intruder being the main targets of the attack. Beak alone is used as a weapon of offence during these chases and dives.

All other animals like monkeys, squirrels, cats, snakes, and ornithologists, who happen to climb the nesting tree intentionally or accidentally are swooped upon and dived at. Vicious jabs of the beak are given, often drawing blood. When a human climber refuses to leave the nest inspite of these attacks or when convinced of their inability to drive away the intruder, one or both the guardians would perch in a nearby branch and exhibit extreme agitation by pecking at the branch, their own legs and claws or the mate sitting next, often cawing and making occasional dives at the intruder in between.

Another feature of defence in Jungle Crow is that it is carried out only by the owners themselves. They do not get any support, moral or otherwise, from other members of the species or the House Crow whose call of help is often responded by the Jungle Crow.

Nest-construction

Selection of site

Mating in the Jungle Crow is indicative of the fact that it is shortly going to start building its nest. The first step towards the construction of a nest is the selection of a suitable site. It has not been possible to ascertain beyond doubt as to which sex makes the final selection as regards the suitability of a site, as the Jungle Crow could not be marked before the start of the actual construction or occupation of the nest. Marking at roosts before the commencement of the breeding season does not prove fruitful because hardly any of the few (marked) birds could be located later in the study area; presumably because of their wide dispersal in the breeding season. The birds marked with rings at nests during the previous years too could not be identified at first sight as at the time of marking only bands of a single colour were used and the sex of the ringed bird of the nest deduced and recorded by its subsequent behaviour (particularly its position at the time of sexual union). On two occasions birds which seemed to roam about from tree to tree with a stick in beak, apparently looking for a suitable nesting site, were shot and one of them turned out to be a male while the other a female.

Situation and location of the nest

Normally a vertical fork, preferably a stout one, near the top or on one of the outermost branches of a tall tree (Plate VI, Fig. 6) is selected on the outskirts of, or near, human habitation, in well wooded, open, cultivated or waste land. It does not as a rule construct in buildings. Occasionally, loops offered by telephone, telegraph or even insulated electric wires, are utilised for constructing a nest.

Nesting material

Selection of the site over, the couple gets busy with the construction of the nest. Dry twigs and sticks are picked up from under the trees and hedges around the farms and fields. If fallen sticks are not readily available twigs from trees and sticks from hedges and fences are wrenched off and carried to the site in the beak. Wires are also occasionally made use of.

All these material are utilised for the construction of the outer cup.

For the lining of the nest cavity softer and pliable material, like coconut fibre, grass roots, grasses, palm fibres and hairs (human, horse or animal), are collected. The dry material may be moistened with water before use.

Mode of construction and share of sexes

Both the partners bring in building material and take part in the actual construction. Each prefers to fix the material brought by him or her but the male would often pass on material brought by him to the female if she happens to be at work and wait for her to fix it before making the next material-hunting trip together (Plate VII, Fig. 5). But he too is as adept in arranging and fixing a difficult stick as the female. The arranging of a stick or twig does not normally take more than a few seconds, but when some difficult stage is reached or an unusually thick or hard stick is to be adjusted to satisfaction the bird(s) may spend a few minutes for the purpose.

In the earlier stages of construction the material brought (sticks, twigs, wires, etc.) are piled in the fork in a criss-cross manner. They appear like a bunch of sticks put loosely in a fork. their ends projecting in all directions. When this pile is about 15-20 cm. in thickness and about 24-30 cm. in diameter additional sticks and twigs are added tangentially till a massive, broad cup-shaped structure 35-40 cm. in diameter and 12-15 cm. deep with walls 10-12 cm. thick, takes shape. The inner cavity of this cup is lined with softer material already listed above. The female does the major work of lining the nest, the male bringing in the material oftner than incorporating it in the nest. The female spends hours at a stretch fixing the lining. She applies her breast to smoothen the bottom and sides of the cup after the lining materials have been arranged.

Time required for completion

Both of the pair keep on bringing material and adding it to the nest pile throughout the day. There are, however, short intervals for feeding, love play and rest. Observations on seven pairs revealed that the Jungle Crow take from 7-21 days to complete a nest (Table 23). The birds who start building early in the

breeding season take slightly longer than those who start late. But then there are individual pairs who are more industrious than others and complete their nests in shorter time.

TABLE XXIII.—*Time required for nest building.*

Sl. No. of pair	Construction started on	Construction finished on	Time taken in days
12	3 March	22 March	19 days
14	7 March	21 March	14 days
17	5 March	23 March	18 days
29	9 March	25 March	16 days
33	15 March	26 March	11 days
47	4 March	25 March	21 days
50	16 March	23 March	7 days

The nest

The finished nest is a large shallow cup of sticks and twigs put together, about 35-40 cm. in diameter, 10-12 cm. thick walls, and 36-45 cm. high .The egg chamber is 16-20 cm. across and 10-14 cm. deep. This chamber is lined with coconut fibres, grasses, grass roots, palm fibre, human, horse or other animals hairs (Plate VII, Fig. 6).

Clutch

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

The eggs are laid only when the nest is complete. Sometimes two to four days may elapse between the completion of the nest and laying of the first egg (Table 24).

Laying pattern

As already stated the first egg is laid 24 to 96 hours after of the completion of the nest. The subsequent eggs are normally

TABLE XXIV.—*The lapse between completion of the nest and laying of the first egg*

Sl. No. of the nest	Nest completed on	First egg laid on	Time lapse (in days)
7	25 March	26 March	1
11	27 March	30 March	3
14	21 March	23 March	2
17	23 March	26 March	3
21	2 April	3 April	1
24	5 April	6 April	1
29	25 March	29 March	4
33	26 March	28 March	2
39	1 April	3 April	2
47	25 March	28 March	3
50	23 March	27 March	4
52	6 April	7 April	1

laid at intervals of about 24 hours. Occasionally as much as 48 hours may elapse between two layings (Table 25).

TABLE XXV.—*Laying pattern.*

	Nest Nos.						
	7	14	17	24	33	47	52
1st egg laid on	26 March	23 March	26 March	6 April	28 March	28 March	7 April
2nd egg laid on	27 March	24 March	27 March	7 April	29 March	30 March	8 April
3rd egg laid on	28 March	26 March	28 March	9 April	30 March	31 March	9 April
4th egg laid on	29 March	—	29 March	—	31 March	1 April	—
5th egg laid on	—	—	30 March	—	—	2 April	—

Time of laying

The first as well as the subsequent eggs are normally laid in the morning between 7.00 to 11.00 hours. Occasional eggs may be laid before or after this time. Generally the individual time and pattern of laying is maintained. It was observed that eight females out of eleven laid regularly between 7.00 and 11.00 hours, two laid before 7.00 hours, and one always laid between 11.00 and 18.30 hours.

Clutch-size

Three or four eggs are generally laid in a clutch, but sometimes only two or as many as five are also laid. Out of 102 clutches studied, 42 (or 41.61%) were of 4 eggs each, 30 (or 38.21%) were of 3 eggs each, 12 (or 11.76%) were of 2 eggs each and only 9 (or 8.82%) were of 5 eggs each.

The mean clutch-size for the years 1965, 1966 and 1967 was 3.5, 3.46 and 3.5 respectively (Table 26).

Seasonal variation

As may be seen from the above table, the larger clutches (of five and four) are met with more frequently during the first half of the breeding season. This results in an increase in the average clutch-size and also in the number of clutches, to its maximum in the first half reaching its peak by the third week of April. A gradual decline sets in the number of larger clutches as well as in the number of clutches laid by the end of April, and the average clutch-size sinks down to its lowest by the end of May.

The size, shape, weight, colour, design, intensity and shade of markings vary a good deal in eggs from different clutches and sometimes even in the eggs of the same clutch.

Eggs

Shape

The eggs are broad ovals somewhat compressed towards one end. The shell is hard, compact, fine in texture and fairly glossy.

TABLE XXVI.—*Clutch-size as observed in 1965-1967 (March-May).*

Year	Month	Number of clutches of 2	3	4	5	Total	Mean clutch-size
1965	March	—	3	5	—	8	3 6
	April	2	5	5	2	14	3.5
	May	2	4	4	1	11	3.4
	Total:	4	12	14	3	33	3.5
Percentage:		12.1	36.4	42.4	9.1		
1966	March	—	4	3	1	8	3.6
	April	3	7	6	2	18	3.4
	May	2	5	5	1	13	3.4
	Total:	5	16	14	4	39	3.46
Percentage:		12.8	41.0	35.9	10 3		
1967	March	—	3	3	1	7	3.7
	April	2	5	6	1	14	3.4
	May	1	3	5	—	9	3.4
	Total:	3	11	14	2	30	3.5
Percentage:		10.0	36.7	46.6	6.7		

Colour and markings

The ground colour may be any one of the many shades of bluish green. There are blotches, streaks, smears, freckles, and spots of brown or pale purple all over, more so at the broader end (Plate VII, Fig. 3, right).

Size

A substantial number of eggs from nests under observations were measured and weighed. On the average the eggs measure 42.0 × 28.6 mm.; maximum 47.0 × 29.5 and 42.0 × 26.0 mm. (Table 27).

TABLE XXVII.—*Size of eggs* (*Corvus macrorhynchos* Wagler).

Length in millimetres.

Year	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5	40.0	40.5	41.0	41.5	42.0	42.5	43.0	43.5	44.0	44.5	45.0	45.5	46.0	46.5	47.0	47.5	Breadth in mm.
1965	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	26.0
	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	27.0
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	27.5
	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	28.0
	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	28.5
	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	29.0
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	29.5
	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	30.0
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	30.5
1966	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	26.5
	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	27.0
	—	—	—	—	—	1	1	1	1	1	1	—	—	—	—	—	—	—	1	1	—	—	—	—	27.5
	—	—	—	1	1	—	—	—	—	1	1	1	—	1	—	—	1	—	—	—	—	—	—	—	28 0
	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	28.5
	—	—	—	—	—	—	—	2	—	—	—	—	—	1	1	1	—	1	1	—	—	1	—	—	29.0
	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	29.5
1967	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	27.0
	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	1	1	—	—	—	1	—	—	—	28.0
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	1	—	—	—	—	28.5
	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	29.0
	—	—	1	—	2	—	—	—	—	1	—	—	1	1	1	1	1	1	1	1	1	1	1	—	29.5
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	30.0
	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	30.5

Average of 12 eggs 41.9×28.3

Average of 30 eggs 41.5×28.5

Average of 21 eggs 42.5×28.9 mm.

Average of 63 eggs : 42.0×28.6 mm.

Weight

On the average the egg weighs 18.39 grams, the maximum being 20.5, and the minimum 16.5 grams (Table 28).

TABLE XXVIII.—*Weight of eggs 1966-1967.*

Year	No. of eggs	Weight in grams									
		16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	Mean
1965	12	—	1	3	2	3	2	1	—	—	18.20
1966	30	1	3	4	6	5	6	3	2	—	18.38
1967	21	—	2	4	2	3	5	2	2	1	18.60
Total	63	1	6	11	10	11	13	6	4	1	18.39

A detailed comparative study of weights of successive eggs was undertaken in a limited number of seven clutches. It appears that the first egg is the lightest and the last is the heaviest, but with no definite weight-pattern in between (Table 29).

TABLE XXIX.—*Weights of fresh successive eggs in 7 clutches.*

Sl. No. of clutch	Egg No.	Wt. at laying gm.	Average wt. of clutch
I	1	17.0	17.87
	2	17.5	
	3	18.0	
	4	19.0	
II	1	18.5	18.83
	2	19.0	
	3	19.0	
III	1	18 0	18.62
	2	18.5	
	3	19.0	
	4	19.0	
IV	1	17.5	18.37
	2	18.5	
	3	18.5	
	4	19.0	
V	1	18.0	18.75
	2	19.0	
	3	19.0	
	4	19.0	
VI	1	17.5	18.33
	2	18.5	
	3	19.0	
VII	1	18.5	18.67
	2	18.5	
	3	19.0	

Determinate layer

The Jungle Crow does not lay additional eggs to complete a partially robbed clutch or stop laying when additional eggs are placed in the nest to complete the clutch.

In five nests I added four eggs each after the first egg was laid (5 being the largest normal number). In three of these nests 3 eggs, in one 2 eggs and in the other 4 eggs were laid at intervals of 24 hours inspite of the addition.

In seven nests, the first two eggs laid were removed. In four of these nests 2 more, in two 1 more and in one 3 more eggs were laid.

Incubation

Commencement

The Jungle Crow, like its cousin the House Crow, starts sitting (incubation) with the laying of the first egg. It does not, however, sit as closely in the beginning as the House Crow. The incubation in right earnest starts with the laying of the 2nd egg.

Share of sexes

The female does most of the incubation. She not only sits in the nest throughout the night but also remains in the nest for a major part of the day. The male relieves her during the day from time to time for short intervals of 10-40 minutes, but during these times he prefers to stand guard rather than settle in and incubate. Many a time the male has to be called by the female for relief. But like a dutiful husband he brings food for and feeds the female while she sits in the nest. He brings the food for her in his beak and transfers it to hers. If a particular tid-bit he has picked up is too hard he first rinses it in water and then carries it to her. On an average he makes three such feeding trips in an hour.

Reaction to alteration or substitution of nest-contents during incubation

The female sits in the nest throughout the day, except for short intervals. When she is away the nest is zealously guarded by the male who sits over the edge of the nest or stands astride

over the clutch. On the approach of a human climber the female leaves the nest and defends it. As soon as the climber leaves the vicinity, the female again occupies it. No attention whatsoever is paid to the alteration, *i.e.*, addition to or partial removal of the contents (eggs) as long as one or more of its own clutch is present or the objects added resemble its own eggs, such as plasticine models or House Crows' eggs. As long as one or more of its eggs are in the nest it will not even mind incubating a couple of golf balls placed in its nest. When the whole of the completed clutch is removed the nest is either deserted or a fresh clutch is laid. Two such clutches were laid after an interval of 11 and 14 days after the loss. Before the desertion a lot of agitation is exhibited by the birds by way of cawing, circling over the nest and pecking at the edges of the nest. When an object entirely dissimilar to its own eggs, like golf ball or a hen's egg, was added to the empty nest it was either thrown out, devoured or left in the deserted nest. When an artificial clutch of four eggs made of plasticine was placed in a freshly completed nest, it was accepted coolly by the female who started sitting on it but laid its full quota of four eggs commencing from the next day.

Incubation period

After a period of incubation the eggs hatch out generally 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. The eggs hatch out one after the other, in the order of laying after intervals of 12 to 24 hours. The first two eggs often hatch out on the same day, but the rest at 24-hour intervals. Out of 16 nests observed over a period of three years, in ten the last laid egg hatched out after 19 days, in four in 18 days and in two in 20 days (Table 30).

Hatching pattern and success

The young hatch out, one after the other, at intervals of 12 to 24 hours more or less in the order in which they are laid. The first and the second eggs often hatch out on the same day after an interval of about 12 hours. In 57 clutches observed during the course of this study, only in 22 clutches hatching was not cent per cent. Of these 22 clutches it was observed that in 9 clutches the last egg laid did not hatch, in 3 clutches

TABLE XXX.—*Incubation period.*

Year	Nest No.	Last egg laid on	Last young hatched on	Incubation period in days
1965	3	25 March	13 April	19
	5	27 March	14 April	18
	7	29 March	17 April	19
	12	24 March	13 April	20
	14	26 March	14 April	19
	16	28 March	15 April	18
	17	30 March	18 April	19
1966	21	6 March	25 April	19
	29	1 April	19 April	18
	30	31 March	19 April	19
1967	33	31 March	19 April	19
	39	6 April	24 April	18
	42	3 April	22 April	19
	47	31 March	20 April	20
	50	31 March	18 April	19
	52	9 April	28 April	19

the last but one egg did not hatch out, in 7 clutches the last but one egg did not hatch out, in 7 clutches the last two eggs failed to hatch, and in 3 clutches all the eggs failed to hatch (Table 31). In these instances where the full clutches did not hatch, the birds incubated the eggs for 28, 30 and 32 days before finally deserting the nest.

The hatching success in the Jungle Crow is fairly high. Out of 192 eggs laid in 57 nests only 38 failed to hatch. The hatching

TABLE XXXI.—*Eggs that failed to hatch.*

Year	Nest/clutch No.	No. of eggs in the clutch	Egg No(s). that did not hatch
1965	1	4	III
	2	4	III, IV
	4	3	III
	6	3	I, II, III
	9	4	III, IV
	11	3	II
	15	3	III
	18	5	IV, V
	20	4	III, IV
1966	23	3	III
	24	3	III
	26	4	III, IV
	31	5	I, II, III, IV, V
	34	3	III
1967	36	3	III
	38	4	I, II, III, IV
	41	3	III
	44	4	III
	48	5	IV, V
	51	3	III
	54	4	III, VI
	56	4	IV

success is, therefore, 80.2% (Table 32). The unhatched eggs broke or got damaged after the hatched out nestlings moved about in the nest. These were cleared out by the parents.

TABLE XXXII.—*Hatching success.*

Year	Eggs laid	Eggs that did not hatch	Percentage of unhatched eggs	Eggs that hatched	Percentage of hatched eggs
1965	68	14	20.6	54	79.4
1966	49	9	18.4	40	81.6
1967	75	15	20.0	60	80.0
Total	192	38	19.74	154	80.20

Nest Life

Physical features and weight at hatching

The hatchlings are nidicolous. The newly hatched nestlings are fleshy pink in colour. The tip of the beak and claws are whitish and hard. The egg-tooth is whitish. The mouth-cavity is blood red, and without any directive marks. The gape is swollen and pink in colour. The abdominal wall is almost transparent, revealing the intestine and remnants of the yolk sack. At emergence the nestling can emit a weak squeaking sound and raise its neck for food. The eyes are closed. There are faint traces of whitish nestling down restricted to the mid-dorsal, and femoral feather tracts, and filoplumes on the wing and tail region.

The weight of hatchling at emergence is slightly less (0.5 to 1 gram) than the egg from which it emerges.

Brooding, care and feeding of the young

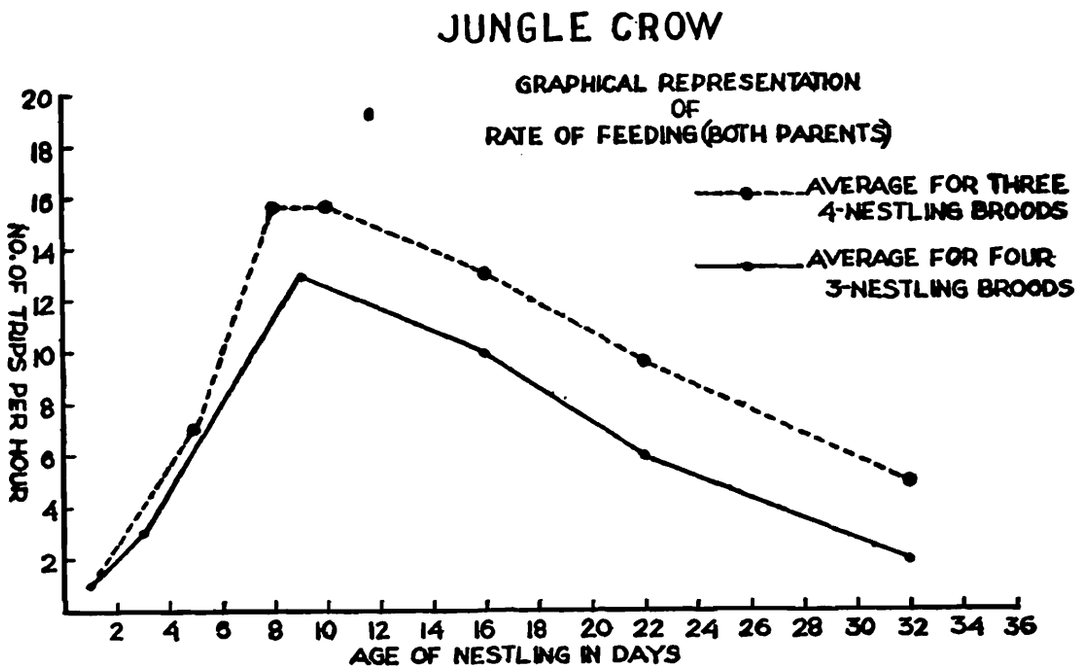
The freshly hatched young are kept warm during the night by the mother and protected from strong sun during the day by both the parents. The brooding by day stops when the fledglings are 3-5 days old but that by night continues till the young are partially fledged, *i.e.*, approximately 17 days old.

The young are never left unguarded. One of the parents always keeps in the vicinity of the nest, especially during the first two weeks, to guard or to warn them against predators and danger.

The feeding of the young by parents starts soon after the emergence of the first chick but it is taken up in right earnest only after the chicks are about or more than 4 hours old. They are fed on semi-solid regurgitated food to start with. Both the parents bring food for and feed the young.

Food and rate of feeding

The feeding activity really starts on the second day of the first hatching. Its rate increases with the emergence of the sub-sequent chicks. Both the parents make trips to hunt for food. The peak of this activity reaches by the 8th or 9th day of the hatching of the first chick, and it recedes slowly (Text-fig. 5). At the peak period as many as seven to eight feeding trips an



Text-fig. 5

hour per parent were clocked on several occasions ; this figure for the two parents together is 13-16. Soft, semi-solid food is thrust down the gullet of the young ones during the first 4 or 5 days. As the young grow they are able to swallow more and more solid food. This results in a decrease in the number of feeding trips by the parents. When the chicks are 18-20 days old they may accept food only twice or thrice an hour. This rate of feeding is maintained fairly steadily till the nestlings are about three weeks old, after which there is a further fall in the feeding rate bringing it down to once or twice in two hours, till the fledglings leave the nest.

The food consists chiefly of kitchen scraps like pieces of chapati, bread, boiled rice, cereals and whole grain, bits of vegetables and fruits ; pieces of flesh, offal, carrion, soft-bodied insects, catterpillars, and the like.

Nest sanitation

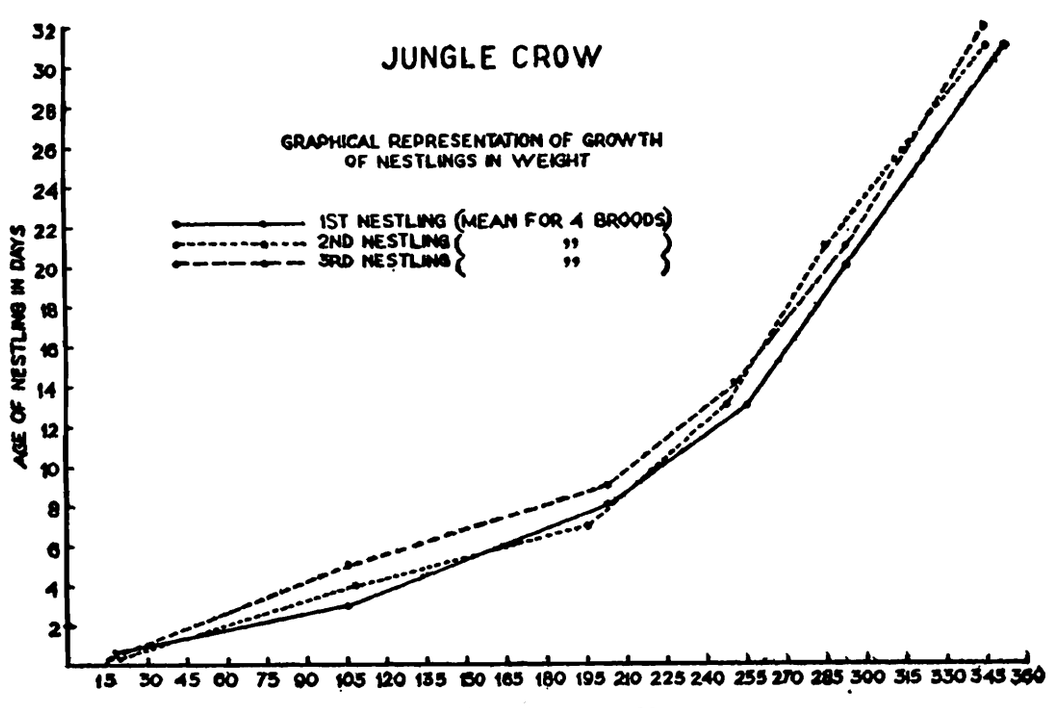
The Jungle Crow is a good house keeper. The occasional disarranged lining material are immediately repaired. After the emergence of the chicks, the egg shells are devoured. The faeces of the young is enclosed in a very delicate faecal sac. After every feeding the parent waits for the fed young to defaecate. If the young does, it is eaten by the parent but only during the earlier days. Both the parents attend to nest sanitation. As the

young grow in age and acquire mobility they start elevating their hind quarters at the time of defecation ; the faecal matter is thus ejected over the rim of the nest to drop underneath.

Growth of nestling

As already stated the weight of nestling at emergence is slightly (0.5 to 1.0 gram) less than the weight of the egg from which it emerges. As little feeding is done during the first 24 hours the chicks gain only 8 to 10 grams during that period. With the increase in the rate of feeding from the second day the weight increases at the rate of 20 to 35 grams a day during the first week, depending upon the number of young present in the nest. An eight-day old chick weighs about 195-205 grams. The rate of gain in weight is reduced to almost half in the next four days. A twelve-day old young weighs around 245 to 255 grams. This rate reduced further by another 50 per cent in the next ten days. When the young is about 22 days old it weighs approximately 300 to 310 grams. This rate is maintained till the age of 32 days, that is about when it leaves the nest, at which age weight is nearly 350 grams (Text-fig. 6).

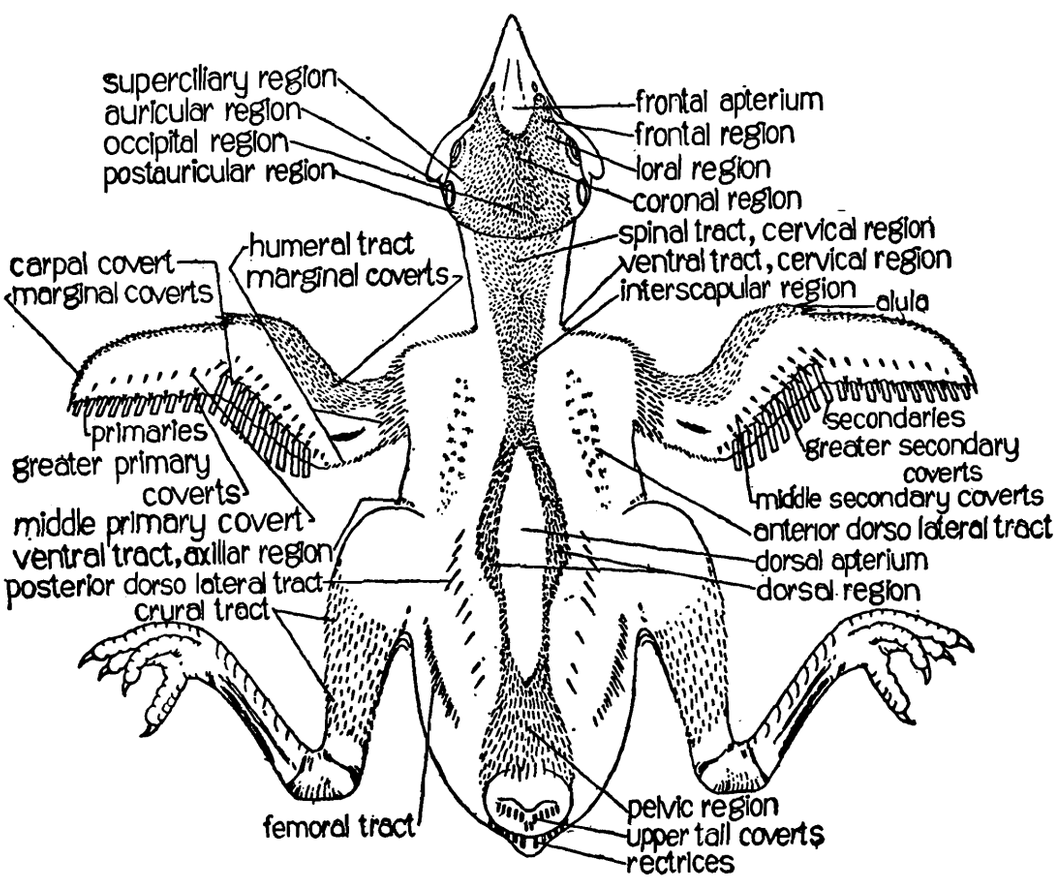
The nestling first to hatch is normally the first to reach its 200 grams and it maintains a steady lead over the subsequent nestlings throughout the nest-life.



Text-fig. 6

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 is about three days old the following feather tracts become prominent although the feathers do not pierce the skin till the fifth or sixth day :

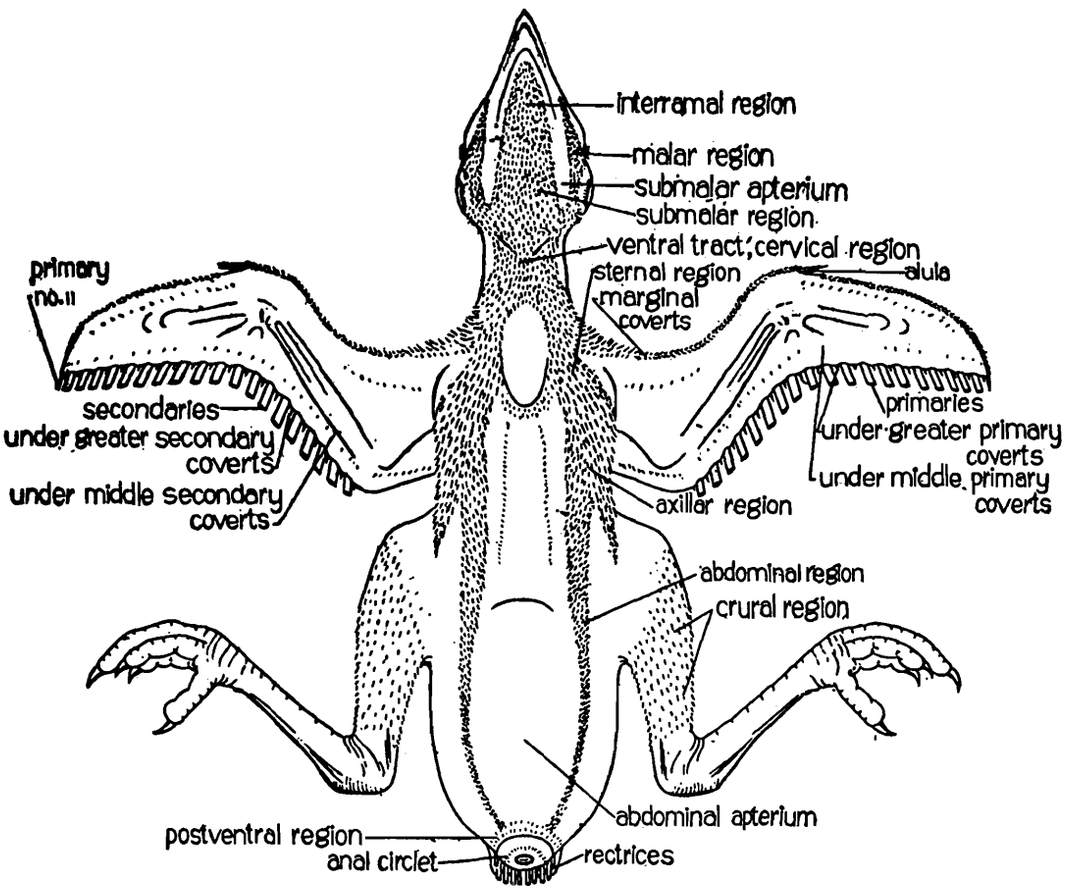


Text-fig. 7—Fledgling (dorsal view)

Dorsal : Spinal (dorsal and pelvic) humeral, femoral, crural and caudal.

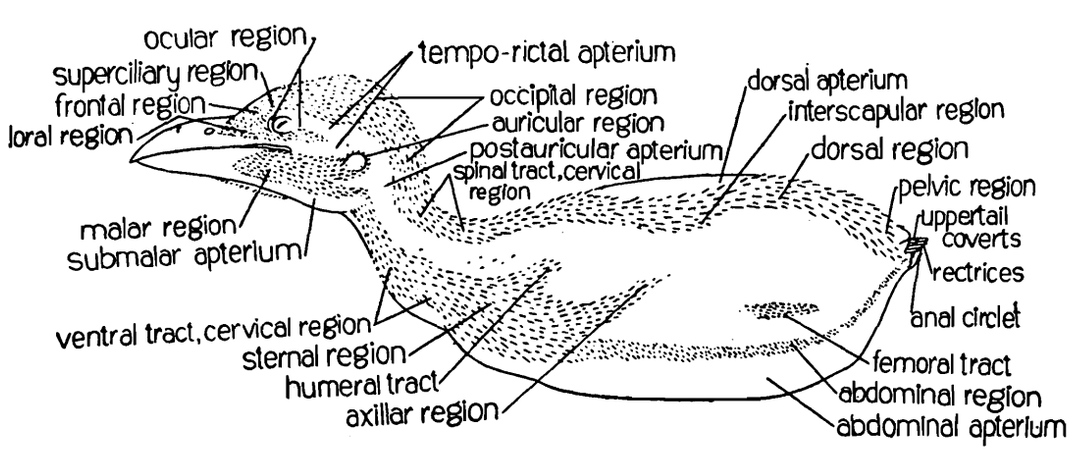
Ventral : Sternal, axillar and abdominal (Text-figs. 7-9).

On or about the fifth day, the capital (dorsal), malar and cervical (ventral) tracts too become distinct. About five or six days old fledglings show all the feather tracts (Plate VIII, Figs. 1 to 3) distinctly. Remiges and rectrices too pierce the skin about the same time as the other body-feathers, but their growth is very rapid. They first appear in the shape of gramophone needle-like structure which elongate for the first few days and then burst at the needle point on or about the ninth day.



Text-fig. 8.—Fledgling (ventral view)

There is a gradual growth of feathers in size, and also in density as more and more feathers sprout on various pterylae, till by the end of the third week the young is almost fledged. By the time the fledgling is about 32 days old it is fully fledged and is capable of flying short distances (Plate VIII, Fig. 4).



Text-fig. 9.—Fledgling (lateral view)

Behaviour of nestlings

For the first five days the eyes of the nestlings are closed. During this period if a soft noise is made near the nest, or the rim of the nest or a part of nestling's body is touched, it reacts by raising its neck and gaping for food. This food response is continued even after their eyes open. When they are about a week old the nestlings are able to distinguish between the parents and the human visitor. A visit by the latter is reacted to by crouching low at the bottom of the nest and clinging to the nest lining. When bodily lifted out of the nest, it reacts by defecating.

After the end of the third week, at the approach of the human visitor the young tries to leave the nest and climb the nearby branches to evade capture. When it is about 4 to 4½ weeks old, it flies out to the nearby tree or branch to escape a human intruder. The parents give out a danger call (a caw) at the approach of a bird of prey or a human intruder. This call too is responded by crouching low at the bottom of the nest. By the end of the fourth week it tries out its wings by indulging in 'dry flying'.

Length of the nestling period

By the end of fifth week most fledglings leave the nest. Occasionally a nestling may stick on till early sixth week (Table 33).

After leaving the nest the young stay around in the branches of the nesting tree or a nearby tree, where they are fed by the parents. Later they start following the parents, staying close to them for a couple of weeks. The parents feed them during this period. The young too attempt to feed by themselves when led to food by the parents.

Nestling mortality

Quite a few of the young Jungle Crow that hatch out do not live to leave the nest. During the course of this study, out of 154 nestlings that hatched out in 56 nests, as many as 36 died before they were old enough to fly out of the nest, so that the nestling mortality was 23.3% (Table 34).

TABLE XXXIII.—*Length of the nestling period.*

Year	Nest No.	Last chick hatched on	Last chick left on	Period in days
1965	3	13 April	17 May	34
	5	14 April	19 May	33
	7	17 April	19 May	32
	12	13 April	19 May	36
	14	14 April	18 May	34
	16	15 April	18 May	33
	17	18 April	10 May	32
	20	5 May	8 June	34
1966	21	25 April	29 May	34
	29	19 April	24 May	35
	30	19 April	21 May	32
	31	3 May	6 June	34
1967	33	19 April	23 May	34
	39	24 April	27 May	33
	42	22 April	28 May	36
	47	20 April	27 May	37
	50	18 April	21 May	33
	52	28 April	31 May	34
	54	3 May	4 June	32
	55	7 May	7 June	31
			Average	33.65

TABLE XXXIV.—*Nestling mortality.*

Year	No. of nests observed	No. of eggs hatched	No. of fledgling that died	Percentage
1965	20	54	13	24.0
1966	14	40	9	22.5
1967	22	60	14	23.3
3	56	154	36	23.3

The majority of deaths occur during the first week. These are due to a number of causes, starvation being the commonest one. Other causes are interference by predators, chance fall on account of strong winds or while practising flying and other natural calamities. A few deaths due to diseases also cannot be ruled out.

The dead nestlings are thrown out of the nest by the parents. Once I saw a House Crow taking away a thrown out nestling from under a nest, and on another occasion a dog carrying a fallen (presumably injured) but still alive nestling.

Nestling success

The nestling success in the Jungle Crow depends on many factors like fertility of the eggs laid, availability of sufficient food, deaths due to starvation, accidents, predations, disease, natural calamities, etc.

During the present study, out of the 192 eggs laid in 56 nests only 118 young finally flew out of the nest. The nestling success, therefore, works out to be 61.98% (Table 35).

TABLE XXXV.—*Nestling success.*

Year	No. of nests observed	No. of eggs laid	No. of fledglings that flew out	Percentage
1965	20	68	41	60.3
1966	14	49	31	63.3
1967	22	75	46	61.3

3. **Brood parasite of the crows : The Indian Koel, Eudynamys scolopacea** (Linnaeus)

The koel belongs to a group of rather clever birds, parasitic cuckoos, who during the course of evolution have taken to the production of eggs resembling closely to some other species of birds whose breeding season coincide with theirs and has made use of their qualities of good parentship to get their own young raised by them by laying in their nests. The parasitic

cuckoos are known as brood parasites. For this purpose the koel, has selected the most intelligent of the Corvidae and perhaps the most devoted of avian parents, namely, the House Crow, *Corvus splendens*. Not infrequently it also entrusts its domestic responsibilities to its not so bright first cousin, the Jungle Crow, *Corvus macrorhynchos,* and occasionally to its distant kin the Magpie, *Pica rustica* (Harington, 1904). Instances of parasitisation of broods of the Common Myna, *Acridotheres tristis* (Inglis, 1908 : 681). Golden Oriole, *Oriolus oriolus* (D'Abrou, 1927) ; Black Drongo, *Dicrurus adsimilis* (Smith, 1952) and starling, *Sturnus* sp. (Baker, 1927) are also on record. But these were perhaps in desperation for want of something better.

Breeding season

The breeding season of the Koel coincides with that of the House Crow throughout the country. In point of fact, it starts a little earlier when most House Crows are still at the nest-building stage and some sluggard Jungle Crows are still laying. It is these tardy Jungle Crows that get imposed. The breeding seasons of the two species of crows have already been described in the preceding pages, and hence need not be repeated here. Broadly speaking the breeding season of the koel is from mid-April to mid-July beginning a little early in southern India and ending a little late in northern India.

At Poona, where the present study was undertaken, the koel laid mostly in the months of May and June. Fresh eggs were taken from the nests of the Jungle Crow as early as 19th of April and from the nests of the House Crow as late as 1st July. Instances of courtship display, pair formation and copulation, were observed as early as the first week of April.

Territory

Early in the breeding season the male apparently establishes a territory in a promising patch of trees abounding in crows and announces it by its lusty song. The female, in response to the call, visits the territory and stays on, presumably, if she happens to like it. This territory is defended by both of the pair but to an entirely different consequence. Any tres-

passing or visiting female is most welcome to the male (owner) who at once sets forth to woo her even within the sight of his earlier mate, while the female (owner) greatly resents such visitors and never fails to threaten or attack her, finally making her best a retreat. A visiting male, on the other hand, is given all encouragement for an illegitimate union by her irrespective of the presence of her mate. The mate (male) however, extremely dislikes such an adventure and goes after it with all his might. Even the unmated males defend their established territory against any male intruder. It is quite usual a number of unmated males who presumably could not establish or hold their territories, to spend time together in a single large tree.

Defence

The male when defending the territory gradually approaches his adversary, hopping from twig to twig, calling loudly and displaying its threatening posture. The threatening display consists of a little spreading of wings and shaking them, perking the head in a stabbing movement and flicking and waving of the tail. The intruder too strikes a similar posture and calls back without giving any ground. When they are within striking distance the bout starts. Beaks are used as the main weapons of offence and defence. These bouts (or stabbing jabs, to be more accurate) are interspersed with loud, presumably threatening, calls. The duel goes on for minutes together, the length depending upon the tenacity of the intruder or the ferocity of the defender, and ends only with the withdrawal of one of the combatants, usually the intruder. The retreating trespasser is normally chased out of the territory.

The female when defending the territory, approaches her adversary gradually calling and assuming the threatening posture between hops from twig to twig. The threatening display is similar to that of the male. The wings are half opened, the tail is flicked from side to side and the head is jerked forwards and backwards. When the adversaries are within beak's reach of each other the duel starts in right earnest, but never becomes as violent as it often develops in the males. After a while the tresspassing female gets bored and retreats. The tresspassing female, while in retreat, may or may not be chased by the female, but is more often than not chased by the male

if he happens to be around, probably in a last bid for a successful romantic interlude.

Pair formation

To all appearances the koels pair only for the breeding season and that too not very seriously. As has been described, others of the opposite sex are courted and copulated with by both of the pair without the least inhibition. This marital infidelity of the koel has often been commented upon (Dharmakumarsingji, 1954 ; MacDonald, 1960). The courtship consists of the male chasing the female, each uttering its note. The chase often ends up in the female surrendering to him in the branch of a tree. She is often fed by the male after every coition, occasionally even before the act. The copulation is done in the normal bird fashion always in the branches of trees, sometimes even in the vicinity of a coming up crow's nest (MacDonald, 1960 : 130).

Egg laying

Comparative stage vis-a-vis host species

The egg or eggs are laid in the nest of the host species when the latter has just started laying. During the course of this study it was observed that (a) out of 21 nests of *Corvus splendens* in which the koel managed to lay, in 16 nests she laid her first egg after the crow had already laid one, in three nests she laid after the crow had laid two and in two nests after the crow had laid three ; (b) in all the three nests of *Corvus macrorhynohos* the koel laid her first egg after it had laid its first. The koel's egg in a freshly completed crow's nest not containing any of its (crow's) own were never met with. From various observations it is surmised that the female keeps an eye on the coming up nest or nests of crows in her territory. She takes her cue of the proper time for laying from the commencement of incubation by crows who habitually start sitting (on the eggs) as soon as the first egg is laid. Thereafter, the female koel lays her egg at the first possible opportunity. If she is lucky to get a break within the first 24 hours of the sitting of the crow she manages to lay after the crow has laid her first. otherwise after the second or the third.

Clutch-size

I have personally never come across more than three koel's eggs (of a single type presumably the produce of a single bird) in a single nest of the host species, and hence am inclined to believe that normally two and not more than three eggs are laid by a single female koel, at least in a single nest of the hosts. Some previous workers, however, did come across as many as seven (Jacob, 1915), eleven (Abdulali, 1931) and thirteen (Jones, 1916 ; Baker, 1934) koel's eggs of two or three distinct types (presumably the product of as many birds) in a single crow's nest, out of which a maximum of five (all of one type) have been assumed (Jacob, 1915) to be the product of a single female.

Mode of laying

As the House Crow (the chief host of the koel) is known to guard its nest zealously against all intruders, it greatly intrigued the earlier workers as to how the female koel managed to lay in the nest of the ever-vigilant House Crow. It was commonly believed by them that male koel lures the incubating House Crow away from the nest while the female lays in its nest. But my experience, as described below, has been otherwise.

On May 3rd, 1966, at dawn while observing a Jungle Crow's nest at Gul Tekdi, Poona, I saw a shadow slip in the nest soon after the female left it to perch on the top of the nesting tree. As the visibility was poor I took it to be the male taking up his duty without saying the usual 'hullo' to her mate sitting above. On adjusting my binoculars carefully I was intrigued to find a much longer tail projecting out of the nest. A further straining of the eyes rewarded me with a full view of a female koel leaving the nest. I had this particular nest under observation for the past fifteen days or so and had checked it only the previous day and marked the single egg laid on 2nd (of May) morning. Being greatly excited by what I had seen I checked up the nest again. To say that I was greatly surprised to find a freshly laid (still warm, in fact warmer than the crow's egg) koel's egg lying next to the previously marked crow's egg in the nest will be untrue as I had half suspected it. The incident, obviously posed a number of questions in my mind, *viz.*, (a) Was it a freak incident ? or (b) was it the usual mode and time of laying ? or (c) was this dawn laying adopted

in the case of nests of habitually unsuspecting Jungle Crow ? I, therefore, decided to pursue the matter further by watching fresh House Crow nests (the chief host of the koel) in the coming nesting season for similar occurrences. With the breeding season of the House Crow closely following that of the Jungle Crow I did not have to wait for long. I saw the koel's performance repeated twice during the breeding season of 1966 in the House Crow's nests but not so very smoothly as in the case of the less suspicious and less vigilant Jungle Crow's. The House Crow, in one instance, detected the koel as she entered the nest and drove her off before she could lay.

The egg

The koel's eggs resemble those of the host species fairly closely (Plate VII, Fig. 3). They are moderately broad ovals in shape, somewhat compressed towards one end. The texture of the shell is fine and glossless. The ground colour varies from pale sea green to dull olive green, often with a brownish tinge. They are marked all over with specks, spots, streaks, blotches and clouds of reddish brown, warm brown or purple, more so towards the broader end where the markings sometimes take the form of an undefined cap. The size varies from 28-32 mm. × 22.24 mm. The average of 21 eggs was 30.8×23.2 mm.

Period of incubation

The period of incubation for koel's eggs as studied in 12 cases was found to be 13 days, the same as reported previously by Lamba (1963 : 132). Apparently the koel capitalizes on this shorter incubation period, 13 days as compared to 16-17 days of the House Crow (Lamba, 1963a : 128) and 18-20 days of the Jungle Crow (Lamba, 1965a : 430). It usually lays after the crow has laid its first egg ; therefore, the young koel is the first to emerge. Even when the koel has been as late to lay as after the crow's third egg the young koel hatches out along with the first of crows, getting a fair chance to compete with the fosters.

Fertility

The fertility in the koel's eggs as studied in 39 cases was

found to be 100 per cent. Never in my twelve years of experience have I come across a koel's egg that failed to hatch. This absolute fertility of the koel's egg is perhaps due to its parasitic habit (survival value). They cannot, obviously, afford to lay infertile eggs in the nests of the hosts for which they have to work so hard and get so meagre an opportunity.

Physical features and weight at hatching

The young koel often hatches a day or two earlier than its foster brethren. At emergence it weighs approximately 7 grams. Its body is entirely devoid of feathers. The skin is brownish in colour as against pink of the nestling crow (Plate VII, Fig. 6). The eyes are closed. The colour of the beak and claws are whitish and hard. Once an egg (in advanced stage of incubation) hatched out after it had been kept in a steel almirah for 24 hours. The nestling could be heard from inside of the shell approximately four hours before it broke the shell to emerge. At emergence it could emit a weak sound and could raise its neck (when touched) to gape for food.

Care and feeding by foster parents

The crows start feeding the koel nestling in right earnest with the zeal and enthusiasm of real proud parents. For the first couple of days it is fed on semi-solid, regurgitated food. After about three days the nestlings are able to swallow soft solids. The food comprises mainly of soft-bodied animals (caterpillars, worms, centipeds, etc.), kitchen scraps, grains, fruits and similar vegetable matter. Both foster parents bring food for and feed the young koel. The feeding trips are so arranged as to leave one of them in immediate vicinity of the nest to guard against predators.

As a result of immaculate care taken by the foster parents the young koel grows rapidly and is the healthiest occupant of the crow's nest. By the end of the first week its weight increases seven to eight times its weight at emergence.

By the end of the second week the body-weight of the koel nestling increases by twelve times and at the end of the fourth week, when the young koel is ready to leave the nest she weighs about 120-130 grams, approximately 17-18 times its weight at emergence.

Donning of feathers

As already stated the young koel is practically devoid of feathers at emergence though a few neossoptiles may be discovered on the dorsal feather tracts on very close examination. The contour feathers, remiges and rectrices (Text-figs. 7-9) start piercing the skin by the end of the first week in the form of blunt needle-like structures. By the middle of the second week, the ends of these needles break open into small tufts which gradually elongate into rachis and vane. By the end of fourth week the young are fully fledged. The sexes can be differentiated by the middle of second week when the females start showing their spots and bars and their colour remains dark brown (Plate VIII, Fig. 6). The males on the other hand remain uniform black except for a row of whitish spots across the wing coverts. The general colouration of the fully fledged young is somewhat similar to that of the adults, but slightly darker in the female nestlings.

Young koel's behaviour

The young koel, unlike other young cuckoos, does not eject the eggs or young of the host species. This fact was recorded as early as 1907 by Dewar who at that time held an enquiry into the parasitic habits of the koel (Dewar, 1907). The only unfair advantage the young koel takes is that it emerges a little earlier than its foster brethren and by the time they hatch out it is already big enough to raise its neck oftener and higher to obtain more food from the foster parents. The young koel seems to have an insatiable hunger and goes on greedily devouring large proportions of the food brought by the parent crows, depriving the young crows of their legitimate share. As a result, all but one, occasionally two young crows die of starvation when their parents are unwillingly entertaining a koel nestling. When the number of young koels happens to be two rarely a young crow can manage to survive.

The young koel otherwise lives in amity with the young crow/crows, if any manage to survive, and leaves the nest along with them after about four weeks of nest-life. Even after leaving the nest it follows its foster parents from tree to tree demanding food. Although not well adapted for terrestrial movement, it often alights on a stone or boulder to ask food when the foster parents are feeding on the ground. The procedure for

asking food is the same as that of the young crows. It can even manage a hoarse caw very much resembling that of the young crows. When the young koel is going about after its foster parents it also tries to feed itself independently on figs and the like. Presumably it breaks away from the fosterers after it acquires enough self-confidence to feed by itself.

Nestling mortality

The nestling mortality in young koel's is extremely low. I have never come across a dead koel nestling in a crow's nest. I wonder if any ever die of starvation. Theoretically, however, starvation death is possible if there happens to be more than two or three of them in a single nest and one (or more) of them is rather late in hatching out. In such a case the last to emerge may not be allowed enough opportunity to obtain food from the foster parents and may perish as a consequence. Natural calamities (like accidental fall as a result of storm), interference by small inquisitive boys and disease appear to be the main causes of loss of nestling in koel. I have missed only one koel nestling during the period of study when 21 nests containing 24 koel fledglings were under observation. The ratio works out roughly to 4.2 per cent.

Parent koel's behaviour

The Koel, after having laid her egg/eggs in a crow's nest, forgets all about it. She does not make any attempt to feed her own young after they hatch out or subsequently when they finally leave the crow's nest.

Incidence of parasitism

During the period of study it was noticed that while parasitised nests of the Jungle Crow were barely 0.5%, at least 10% of the House Crow nests harboured egg(s) of the koel.

Breeding season

Duartion

Most birds do not breed throughout the year. Generally the

various membes of a particular species in a given area breed only during a particular period or periods in a year. In this (these) period(s) they establish territories, pair off, copulate, construct nests, lay eggs, incubate and raise their brood(s). Such a period(s) is (are) known as the breeding season(s) for the particular species. The breeding seasons 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 the above-mentioned schedule.

The breeding season is initiated, according to the current belief, by a complex of factors, like (a) natural instinct and (b) physiological changes, brought about by various ecological stimuli, such as temperature, precipitation, quantum of sunshine, availability of food and changing condition of the habitat, etc.; which often bring about physical changes also. The length of the breeding season for a particular species depends in part on (A) time required for :—

i) establishment of territory,
ii) pairing up,
iii! construction of nest,
iv) laying,
v) incubation period, and
vi) nestling period.

(B) the interval between the desertion of a nest and renesting; and (C) interval between the fledging of one brood and commencement of construction of another nest or laying, and the number of broods raised during the season.

During the course of this study it was observed that at Poona the House Crow, *Corvus splendens,* has a single annual breeding season of about 3½ months from late April to early August. A number of previous workers have, however, recorded different times and periods of the year as its breeding season in different parts of India. Hume (1889 : 8) records that the "breeding par excellence is June and July but an occasional nest will be found earlier even in Upper India and in Southern and Eastern India a great number lay in May" According to Dewar (1919 : 27-28) the breeding season of this species "in Northern, Western and Central India is June to August, most eggs being laid between June 10th and 30th. In Bengal and Burma from March to May, also in January and December. In South India from April to June, a few birds, however, nest in November and December or February and March" Whistler (1928 : 8) remarked

that the "breeding season is very regular in the north-west, eggs being laid from the middle of June till the middle of July. In the rest of India numbers lay in April and May and occasionally nests are found in November, December and January" Baker (1932 : 16) writing on the subject stated "Over Eastern Bengal, Bihar and Arakan the normal breeding season is March and April but in Dacca and Mymensingh there are two well defined seasons : December, January and February in winter and April, May and early June in the hot weather. In Ratnagiri and in other parts of Bombay Presidency Messrs. Vidal and Davidson found that they had two similar seasons, the principal months being November and December and then again in April and May. Over the rest of India the favourite months seem to be June and July." Ali (1946 : 2) records "In Western India House Crows nest between April and June, in Bengal slightly earlier ; while in the heavy rain fall areas of south-west India breeding is usually over before the onset of the south-west monsoon in May" Lamba (1963 : 123) reports that "around Poona breeding season commenced by the end of April, most eggs and nests were found in May-June and fledglings in June-July. Occasional nests were also met with in August. On the other hand, at Vellore (N. Arcot, Madras) the nests did not start coming up till nearly the middle of May. Most of the eggs were found in June and most fledeglings in July. The breeding season lingered fairly well into August, when a few nests with fledglings could be located."

In the case of the Jungle Crow, *Corvus macrorhynchos,* too. it has been noticed during the present study that it too has a single annual breeding season of about four months lasting from the end of February to the end of June. Some previous workers have, however, recorded different, lengthier and two distinct breeding seasons for this species also in various parts of India. Hume (1873 : 411, 1889 : 4) writing about the breeding season of this species stated : "March to May is, I consider, the normal breeding season ; in the plains the majority lay in April, rarely later, and in the hills in May ; but in the plains a few birds lay also in February." According to Whistler (1928 : 4), "The various races of Jungle Crow throughout India agree for the most part in laying their eggs from March to May, but in the plains a few nests will be found with eggs as early as the middle of December" Baker (1932 : 7) writing on the subject stated : "The Northern Indian race breeds during December and

Januray in Bengal and have myself taken eggs as early as the 27th November in Eastern Bengal. In Bihar a few birds breed as early as second week in January, but over the rest of its range across India as far west as the United Provinces and as far south as the Central Provinces the normal breeding season seems to be late March to early May, most eggs being laid in April before the 20th of that month. The breeding season of the Jungle Crow throughout Southern India seems to be March, April and May. Major C. E. Williams took for me a fine series of their eggs between 9th of March and 3rd of May ; Bourdillon and others took eggs from 27th February to 20th of May in Travancore. Davidson and Miss Cockburn give April and May as the breeding months in the Nilgiris, though Darling took a clutch of six eggs at Ooty as early as the 12th of February. In the south of Bombay Presidency most eggs are laid in April and March" Ali (1946 : 5) on the other hand stated: "The normal breeding season in Peninsular India is between December and March or April ; north of Ganges and in Assam and Burma it is usually later, between March and May." But Lamba (1965 : 426) recorded that "In and around Vellore (N. Arcot, Madras) where the present study was made, the breeding season in 1956 lasted from early March to early June. Most eggs are found in April-May and most young in May-June"

Initiating factors

It is rather difficult to give a clear-cut explanation of the dissimilarity between the initiation and length of the breeding season of crows at Poona and elsewhere in India, as the ecological and physiographical data for other areas are not available for comparison. But it can certainly be assumed that breeding is initiated by the operation of a one or more factors mentioned earlier. Various workers all over the world have experienced that these factors affect different species differently 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 & 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). Similar was the behaviour of four species of albatrosses and six species of smaller petrels in New Zealand (Richdale, 1952 : 67). In the desert areas of Africa and Australia, Moreau (1950) and Keast & Marshall (1954) often found the rainfall as the stimulus for reproduction, whereas in western Guatemala Skutch (1950) found a great majority of birds nesting at the height of dry season. Nothing could, therefore, be more logical than Skutch's (1950 : 212) conclusion of his prolonged studies on Central American birds : "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 Poona, the Jungle Crow starts breeding when the days are lengthening and temperatures are rising. The House Crow starts breeding at the height of the hot season and when the relative humidity is increasing, and has its young out by the time the monsoon breaks. At Poona, the initiation and length of breeding season of crows was observed to depend more on the availability of food rather than on any other single factor. The breeding season of the Jungle Crow coincides with the fruiting of *Ficus* species, a favourite food of the species ; whereas the broods (hatchling) of the House Crow emerge just as the rains start, ushering a boom in insect life, vegetables and fruits, the main food of nestlings. These observations are supported by similar observations of other workers elsewhere on a number of avian species (Skutch, 1950 : 216-222 ; Moreau, 1950 : 262-265 ; Thomson, 1950 : 180-184 ; Bertram *et al.,* 1934 : 819-823 ; and Marshall, 1952 : 326-333).

Pair formation

Duration of bond

Extensive studies of some ornithologists, such as Heinroth (1928), Lack (1940) and others, indicate that most birds pair up only during the breeding season, the two sexes staying together for a part or whole of it, according to their accepted share of domestic responsibilities. Pairing for life has also been hinted at in the case of the Black Crow, *Corvus capensis* (Skead, 1952 : 434), Rook (Yeats, 1934 : 33) and a few other species (Baker,

1935 : 472, Lack, 1940 : 271 ; Robinson, 1949 : 108 ; Lamba, 1963 : 11), but no conclusive proof of their doing so has so far been furnished, except perhaps for swan (Heinorth, 1912).

Both the species of crows studied at Poona 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.

Recognition of mate

Birds are supposed to recognise their own species through their association with their parents, and their opposite sex through courtship behaviour or sexual recognition signs. The recognition of own species in birds through association (with parents) in nestling stages has been strongly indicated by the behaviour of hand-raised birds who from the nestling stage treat their human keepers as parents. Nice (1943 : 192) writing the subject states : "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 Corn-Crake 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 crows, both the House as well as the Jungle, recognise their own species by their association with the parents during the nestling period.

But how the opposite sexes of these crows recognise each other could not be determined with certainty, as no specific activity, courtship behaviour or sexual recognition signs were observed.

Lack (1953 : 64) has quoted Darwin to say 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. "As none of the above-mentioned qualities is possessed by the males of both the species of crows, it is not possible to attribute the definite factors responsible for sexual attraction in these species. It would appear, therefore, that there

are other factors for this purpose, operating in nature, but are still not inteligible to man.

At the nesting stage both *Corvus splendens* and *Corvus macrorhynchos* recognise their mates by visual as well as auditory cues. Alarm calls of *Corvus macrorhynchos* promptly brings its mate to the scene. The female of this species sometimes even calls the mate for nest relief. In *Corvus macrorhynchos* the partner incubating or guarding would leave the nest only when its mate alights on the nesting tree or near the nest.

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

However, the recognition of its own species and of the opposite sex in koel must be inherited, as its own parents are not associated with it in the nestling stage. This agrees with Cushing's (1941b) suggestion that with some birds the recognition of mates must be an inherited matter.

Stability of bond

In crows, the pairs once formed, are always stable. There are no desertions once the nest building has started. The partners are faithful and considerate. They share the various domestic duties and responsibilities. The male Jungle Crow often feeds his spouse when she is incubating. No attempts are ever made for any extramarital sexual union by any one of the pair. The crows are monogamous in the strictest sense. Second mate is sought and acquired only in the event of death of the first one, and that too if it occurs in the first half of the breeding season.

This behaviour of the crows is comparable to many other Passerine species like Song Sparrows (Nice, 1943), Myna (Lamba. 1963b ; Sen Gupta, 1968), Rook (Yeates, 1934) to cite a few.

The koel, on the other hand, though pairs up for the breeding season does so only half-heartedly. Both of the pair freely indulge in promiscuous or extramarital conjugation.

Copulation

Most birds copulate during the pair formation, nest building

and/or egg laying periods. Some species have been reported to stop copulating with the laying of the first egg (Allen & Nice, 1952 : 621), while others continue even after the incubation has started (Summers Smith, 1955 ; Berger, 1957 ; Lamba, 1963, 1965b), or even after the eggs hatch (Van Tyne & Berger, 1959 : 272). The crows copulate very frequently during the nest building and laying periods.

The crows copulate in the normal bird fashion. Varghese (1935 : 186), however, suggested a vent to vent coition in crows while lying on the ground. His (Varghese, 1935) conclusions were however belied by my own observations, as well as those of Ali (1927 : 823), Acharya (1951 : 170), Jamal Ara (1954 : 940) and Lamba (1963a : 124 ; 1965a : 426) all who have seen crows copulating in normal bird fashion.

The copulation in the Indian crows, like most other birds takes place on ground, in trees or bushes, on tops and ledges of buildings, on telephone and telegraph wires, and in nests. The koels were always observed to copulate in trees in the normal avian style. The copulation in Rooks (Yeats, 1934) is known to take place only on the nest. This habit of copulating at the nest alone can be attributed to its colonial nesting. Many colonial birds are known to copulate at the nest.

Rooks are also known to copulate during the incubation period (Yeatas, 1934 : 36), whereas both the crows studied by me stop copulation after the commencement of incubation. I wonder if the habit of Rook also has got to do something with its colonial nesting. Some colonial nesting birds are known to copulate throughout the incubation period (Lamba, 1963c).

Salim Ali (personal communication) has reported copulating House Crow occasionally being mobbed by others of the species present in the vicinity. I have personally never come across such a situation during the course of the present study. Yeats (1934 : 38-40) has described such mobbings in the case of the Rook. He maintains, however, that others of the species attack only if the copulation is illicit or promiscuous.

Territory

Historical sketch

Most birds resent intrusion by others of their sex and species, other species of birds (especially predators) and other

animals in general inside a limited area around or adjacent to their nest or proposed nesting site, called territory. Territory was "casually mentioned as early as 1622 in regard to the Nightingale in an Italian book on the Aviary (Olina), and noted occasionally by other writers in the 17th and 18th centuries" (Nice, 1943 : 162). Altum (in Mayr, 1935) a nineteenth century (1868) German Zoologist developed the territory concept in great detail in his book 'Birds and their life' But it was Howard (1907-14, 1920, 1929, 1935) who first propounded the organisation of territory as a controlling principal in bird life. None of these earlier workers, however, attempted to define in a few words what they precisely meant by the term territory, although they did clearly convey its implications. Quite a few of the comparatively recent workers have attempted to define the term territory. For example, Mayr (1935) defined it as "an area occupied by one male of a species which it defends against intrusions of other males of the same species and in which it makes itself conspicuous" This definition was not found very satisfactory as it did not cover the cases where the females held territories. Tinbergen (1936, cited by Nice, 1941) covered the point by defining it as "as area that is defended by a fighting bird against individuals of the same species and sex shortly before and during the formation of a sexual bond" Lack (1939 : 180) put forward a still more elaborate definition by stating that the "territory is an isolated area defended by one individual of a species or by a breeding pair against intruders of the same species and in which the owner of the territory makes itself conspicuous" At about the same time, Noble (1939) by avoiding maze of factors involved defined the term territory simply as "Any defended area". Van Tyne and Berger (1959 : 267) tried to improve upon it by paraphrasing it as "It is characterized by a positive reaction to a particular place and a negative reaction to other individuals"

The claim to a territory may be laid either before or after pair formation and sometimes even after the selection of the nesting site. The occupation of the territory may be announced by song, display or by mere presence. The territory may be defended by warning note, threat display or actual combat and chase. The size of the territory may differ according to the pugnacity of the owner(s) and on the space available per nesting pair in the area.

Type and category

Hinde (1956 : 342) categorised four types of territories, based upon the extent of breeding activities carried out within the limits of the territory :—

Type A. Large breeding area within which courtship, copulation, nesting and food seeking usually occurs.

Type B. Large breeding area, which, however, does not furnish most of the food.

Type C. Small nesting territory as in colonial birds.

Type D. Pairing or mating territories.

During the course of the present studies it was observed that in the case of the House Crow, *Corvus splendens*

(a) the territory is claimed after the nesting site has been selected,

(b) the occupation of the territory is announced by the mere presence of one or both of the pair,

(c) courtship and copulation usually takes place inside the territory,

(d) most of the food for self and young is obtained from outside the territory,

(e) the territory is defended by both sexes by warning note, pursuit and attack,

(f) the territory is occupied and defended during the breeding season only,

(g) a well marked social defence system is employed whereby several nesting pairs of the neighbourhood join the defence efforts of a threatened pair against predators,

(h) the territorial limits (area of defence) vary according to the type of intruder.

It follows therefore that the House Crow, *Corvus splendens* :

(a) sustains a territory which is intermediate between types B and C of Hinde's (1956 : 342) classification ;

(b) occupies and defends it after the pair's selection of the nesting site ;

(c) defends it mainly for nesting site, nest, eggs and brood.

In the case of Jungle Crow, *Corvus macrorhynchos* it was noticed that :

(a) the territory is claimed after the pair formation,

(b) the occupation of the territory is announced by mere presence of the pair,

(c) nesting site is selected within the territory,

(d) courtship and copulation takes place within the territory,
(e) nesting material are collected from within the territory,
(f) most of the food for self and young is procured from the territory,
(g) the territory is defended by both sexes by warning note, pursuit and attack,
(h) defence is at its strongest when the young are less than 2 weeks old,
(i) the territory is occupied and defended only for the duration of the breeding season, and
(j) the size of the defended area differ with different types of intruders.

It follows therefore, that the Jungle Crow, *Corvus macrorhynchos :*

(a) keeps Hinde's (1956 : 342) A type of territory,
(b) occupies the territory after the pair formation,
(c) defends it also as feeding area in addition to its containing the nesting site, nest, clutch and brood,

Function of the territory

A number of theories have been put forward as to the function of the territory, of which the important ones are :—

1. To conserve food for the young (Atlum, 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).

My observations during the present studies prompt me to conclude that the main functions of the territory in *Corvus splendens* and *Corvus macrorhynchos* are to afford protection to nest, eggs and young, that is, the functions proposed by Nice (1933d), Mayr (1935), Lack (1935), Noble (1939) and Tinbergen (1939).

Nest

Nesting sites

After pair formation both sexes of crows together start

looking for a suitable nesting site. Van Tyne and Berger (1959 : 274) have also mentioned about selection of nesting site being done by both sexes in corvids. A lot of hesitation is exhibited while the selection is being made. Many possible sites are visited before a final decision is taken. Many a time a site selected is abondoned on account of its inability to hold the coming up nest or frequent appearance of predators or intruders in the vicinity. It cannot be said with absolute certainty as to which sex makes the final selection. However, from the data presented earlier it would appear that in the House Crow the female has a greater say in the matter, although both sexes make the selection together. No such evidence could be gathered by me for the Jungle Crow.

A thin, vertical, multipronged fork, near the top of the tree or on the outermost branch of a larger tree of the locality is usually selected for placing the nest by both the species of crows studied. Nests have, however, been observed by me as well as recorded by others in smaller trees, ledges and nooks of buildings (Hume, 1889 : 8 ; Baker, 1932 : 17 ; Tiwari, *personal communication*), telephone and telegraph poles and wires (Dewar, 1905 : 25) ; and brackets and loops of electric mains (Lamba, 1965 : 426). It is obvious from the scanty records of such nesting sites that these are unusual nesting sites, occupied presumably because of a general scarcity of usual nesting sites. With the growing tendency to cut down larger trees in urban and suburban areas in order to make room for expansion of cities, and attraction to such expanding areas of more crows who have almost become parasites of man, such a state of affairs is not hard to visualise. Occasional occupation of unusual sites, presumably under similar circumstances, by a variety of Indian species of birds is a well known phenomenon recorded by a number of workers in the past (Holdsworth, 1872 ; Adam, 1873 ; Hume, 1889 ; Beethan, 1903 ; Currie, 1916b, Barnett, 1918 ; Waite, 1920 ; Shuttleworth, 1921 ; Shipp, 1922 ; Inglis, 1922 ; Prater, 1926 ; Bates, 1926 ; Biddulph, 1937 ; Mac Cann, 1941 ; Kingdon-Ward, 1949 ; Parsons, 1950 ; Inglis, 1951 ; Betts, 1954 ; George, 1957, to mention a few).

Yeats (1934) has opined that the Rook returns to the same nest year after year. During the present study a number of nest, constructed chiefly of wires were observed to be occupied every year by the House Crows. It could not, however, be ascertained if the ownership remained constant or changed every year,

Nesting material

Sticks and twigs of small to medium size, and often thorny, are normally used in the construction of the outer structure of the nest by both the species of crows. Metallic wires and strips of various kinds are also incorporated in the outer structure by the House Crow. A number of workers in the past have also recorded this peculiaity of the House Crow (Hume, 1889 : 9 ; Baker, 1932 : 16 ; Dewar, 1929 : 27-28). A very interesting instance was recorded by Dewar (1905 : 26) of a pair of Bombay House Crows who stole gold and silver spectacle frames from an optician's showcase to build their nest with. My own observations as well those of the above-mentioned workers confirm that metallic wires and strips are met with only in the nests located in or around large cities where such objects are more easily available than the normal nesting material. Instances of other species of birds using metallic wires in their nest structure in areas where pieces of wire were easily available have also been recorded ; doves : Walsh (1924 : 1055-1956), Red-vented Bulbuls : Lamba (1968b : 222-223). It follows, therefore, that these metallic articles are used primarily as a suitable substitute and not purposely with an intention to impart additional strength or glamour to the nest structure.

The nest cavity is lined normally by grass roots, vegetable fibres, and animal (including human) hair by both the species of crows studied. Hume (1889 : 9) mentions finding rags, Dewar (1929 : 27-28) pine needles, and Baker (1936 : 16) an old cap in the lining of House Crow nests. None of these material was, however, encountered by me during the present study. The use of these material in the nest lining may perhaps be due to scarcity of normal material or to individual fancy.

Unlike some other passerine species (Lamba, 1963 : 4 ; Sen Gupta, 1965) the crows do not add any additional material to the nest after its completion. Only minor adjustments of a unruly twig or root are undertaken during the occupation.

Nest building

Nest building, both in the House as well as the Jungle Crows, is a job primarily done by the female of the species, although both sexes gather the material. The share of the male House Crow in actual construction of the nest is very little, approximately 5 to 10%, whereas that of the male Jungle Crow

is as much as 20% approximately. Ryves (1944) had suggested four major categories of birds based on the role of sexes in building the nest. Van Tyne and Berger (1959 : 276) have added three more to provide the following list :—

1. Both sexes build the nest.
   a. Male and female share more or less equally.
   b. Male builds dummy or cock nests.
2. The female builds but only the male provides the material.
3. The female builds without the help of 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 Indian crows. It falls generally under catagory 1. As the share of sexes is unequal, female doing the major portion of construction, it is 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.

It normally takes 7 to 17 days for a pair of House Crow and 7 to 21 days for a pair of Jungle Crow to complete the nest with lining and all. The pairs who start building early in the breeding season take comparatively longer 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 crows are rather fast workers. Small to medium size passerines are known to finish a nest in 3 to 9 days ; for example, *Pycnonotus cafer,* 3 days (Dixit, 1963) ; Prothonotary Warbler, 3.3 days (Walkinshaw, 1941) ; *Myioborus miniatus auranticus,* 3-5 days (Skutch, 1945c) ; Cedar Waxwing, 5-6 days (Putnam, 1949) ; *Nectarinia asiatica,* 6-8 days (Bates, 1931 ; Dass, 1964) ; *Dicrurus macrocercus,* 5-10 days (Lamba, 1963b) ; *Acridotheres tristis,* 6-8 days (Sen Gupta, 1965). To finish such a large nest, complete with intricate lining, in 7 days (minimum time observed) is, therefore, quite a creditable feat accomplished by the Indian crows.

Eggs

Laying pattern

The laying pattern in Corvids appears to differ from species to species. Yeats (1934 : 32) discovered that some Rooks laid on alternate days while some did so on successive days. Skead (1952 : 440-441) found some Black Crows laying two eggs within the first 24 hours, and then laying regularly every day till the clutch was complete.

Both the House Crow and the Jungle Crow lay one egg a day, at regular intervals of about 24 hours, usually in the mornings between 7 and 11 hours, till the clutch is complete. On rare occasions, however, as many as 48 hours may elapse between two successive layings. The normal egg-laying habit of crows compares well with some of the other Indian passerines whose time and mode of laying has been recently studied (Ambedkar, 1964 ; Sen Gupta, 1968 ; Lamba, 1968b).

Clutch-size

A good deal of variation was observed in the clutch-size of both the House Crow and the Jungle Crow in my study area. It was noticed that the House Crow lays from 3 to 6 eggs per clutch which agrees with the recorded data on the subject. The average annual clutch-size varied from 3.8 to 4.1. The average clutch-size was largest (4.3 to 4.4) in the second quarter of the breeding season. Similarly, in the Jungle Crow it was observed that it laid 2 to 5 eggs per clutch. The average annual clutch-size varied from 3.4 to 3.5. The average clutch-size was largest (3.6 to 3.7) in the 1st quarter of the breeding season. Darling (in Hume, 1889 : 7) has recorded the largest clutch (of six eggs) of Jungle Crow from the Nilgiris but the smaller clutches (2 eggs) of the species have only been recorded from Allahabad (Bingham in Hume, 1889 : 6), Eastern Bengal (Cripps in Hume, 1889 : 7) and Poona (Lamba, 1968a).

The variation of clutch-size as noticed in the Indian crows at Poona as well as these recorded from elsewhere in India, is true of most avian species all over the world, though a few species invariably lay the same number. Geographical variations of clutch-size have been reported in several Central American (Skutch, 1949, 1954), 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, 1947-1948 ; Gilbert, 1936) has also been recorded.

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*

A bird lays as many eggs as it can cover with its brood patch.

2. *Danger or Mortality*

The size of the 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 birds to lay larger clutches (Schneider, 1928 ; Elton, 1942 ; Moreau, 1944). Even quality of food available sometimes affects the clutch-size (Kluijver, 1933).

4. *Physiological capacity*

The number of eggs laid is limited by the physiological capacity of the bird. Even the age of bird is known to affect the clutch-size. Thus, first year birds lay smaller clutches than the older individuals (Ruiter, 1941 ; Kluijver, 1933 ; Wissel, 1927). Very old individuals also tend to have reduced clutches (Jourdain, 1925). Sometimes, an individual bird which lays an unusually large or an unusually small clutch on one occasion tends to do the same on other occasions 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 the present study, it is not possible to single out any one of the above-mentioned factors as solely responsible for the determination of clutch-size in the crows in my study

area. Perhaps a combination of more than one of these factors is at work.

Colour of the eggs

The ground colour and markings, size and weight of eggs vary considerably not only in the eggs of various clutches but also in the various eggs of the same clutch, both in *Corvus splendens* and in *Corvus macrorhynchos*.

The ground colour of eggs of both the species of crows is bluish green (or sea green), those of *Corvus macrorhynchos* being slightly deeper than those of *Corvus splendens*. Hume (1889 : 12) mentions bright blue and pure pale blue eggs of *Corvus splendens*. None of the numerous subsequent workers has reported such eggs, nor have I come across any during the course of this study. It is, therefore, assumed that Hume's (1889 : 12) eggs were perhaps extremely rare freaks or represented cases of mistaken identity. The markings consist of blotches, specks, spots and streaks of purple, dull reddish brown, sepia, gray and neutral tints.

Size of the eggs

Sixty-three eggs of *Corvus macrorhynchos* measured on an average 42.00 mm × 28.6 mm, maximum 47.0 × 29.5 mm and 42.0 mm × 30.5 mm, minimum 36.0 × 28.5 and 42.0 × 26.0 mm. These measurements are somewhat different from Baker's (1932 : 10) of sixty eggs which measured on an average 38.0 × 28.1 mm, maximum 47.0 × 29.8 mm and 42.0 × 30.2 mm., and minimum 36.3 × 29.0 mm and 42.4 × 26.3 mm.

Two hundred and sixteen eggs of *Corvus splendens* measured on an average 38.5 × 26.1 mm., maximum 44.0 × 27.0 and 41.0 × 29.0 mm., and minimum 30.0 × 25.0 and 32.0 × 24.0 mm. These measurements too disagree slightly with Baker's (1932 : 18) average of two-hundred eggs, 37.2 × 27.0 : maximum 44.1 × 27.4 and 41.1 × 29.1 mm. ; minimum 30.4 × 25.4 and 32.0 × 23.0 mm.

Weight

The weight of eggs too, like colour and size, varies greatly even in the eggs of the same clutch. The eggs of *Corvus splendens* weigh from 9.5 to 14 grams (average of 216 eggs =

11.65 grams) and that of *Corvus macrorhynchos* from 16.5 to 20.5 grams (average of 63 eggs = 18.39 grams). The average maximum and minimum weights per clutch were found to be 12.3 and 10.1 grams respectively for *Corvus splendens*, and 18.83 and 17.87 grams respectively for *Corvus macrorhynchos*. I have not been able to trace any published record of weights of the eggs of Indian crows.

Incubation

Commencement

Both *Corvus splendens* and *Corvus macrorhynchos* start sitting over the eggs with the laying of the first one. As no thermocouples were available it could not be ascertained directly if incubation really began with the laying of the first egg, because some birds have been known to sit on eggs without applying heat to them (Van Tyne and Berger, 1959 : 293). But the hatching pattern does indicate that incubation begins with the laying of the first egg. It was noticed that the second egg hatched after an interval of 12 to 24 hours of the first egg. This beginning of incubation with the laying of the first egg in the two Indian crows is quite consistent with some other Corvids reported from other parts of the world (Yeats, 1934 : 43 ; Skead, 1952 : 441 ; Van Tyne and Berger, 1959 : 294).

Share of the sexes

In *Corvus splendens* it was observed that both the male and the female take turns in incubating the eggs during the day time, but the female alone incubates during the night. Skutch (1957) has suggested that incubation by both sexes was the primitive method among birds. In the case of *Corvus macrorhynchos* it was noticed that female alone incubated during the day as well as the night. The incubating behaviour of *Corvus macrorhynchos* agrees with that of the other Corvids (Van Tyne and Berger, 1959 : 507) It, therefore follows that as far as incubation is concerned *Corvus splendens* follows a primitive pattern as compared to *Corvus macrorhynchos* and many other corvids.

Period of incubation

For the determination of the period of incubation Nice's

(1954) method of calculation from the laying of the last egg to the hatching of that egg was followed. The incubation period of *Corvus splendens* was found to be 15-17 days during the present study at Poona. From Vellore (N. Arcot, Madras) Lamba (1963a : 128) has recorded the incubation period of this species from 16-17 days. Similarly, the incubation period of *Corvus macrorhynchos* was noticed to be 18 to 20 days at Poona during the present study, whereas at Vellore in 1956 it was found to be 17 to 19 days (Lamba, 1965a : 431).

Several theories have been put forward by a number of workers to explain the differences in the length of incubation time in various orders of birds as well as in individuals of the same species. Nice (1954) has contended 'rate of development of the embryo' to be the most critical factor in the determination of incubation period. Several others (*see* Van Tyne and Berger, 1950 : 296) have commented that long incubation and nestling periods are found in birds that are relatively safe from predation and other damages. Skutch (1954 : 31) found that in Tyrant Flycatcher the less accessible the nest, the slower the development of the eggs and young. At poona crows eggs are collected by some people to make 'Kajal' which is supposed to be good for eye sight whereas at Vellore no such interference was observed. The slight difference in the incubation periods at Poona and Vellore birds may, therefore, be due to slight difference in temperature that has an influence on the inherent rate of embryos' development and differences in the safety of the nests at the two places. The periods of incubation of both the Indian crows *i.e.*, 15-17 days in the House Crow and 17-20 days in the Jungle Crow compare well with other corvids *i.e.*, 18 day incubation period of the Rook (Yeats, 1934 : 57), and 18-19 days of the Black Crow (Skead, 1952 : 442).

In the course of the present study at Poona, in two nests of *Corvus splendens* where the eggs did not hatch out, the birds were observed to incubate for 30 and 41 days before deserting. At Vellore in 1956 (Lamba, 1963 : 128) two pairs of this species were observed to incubate for 27 and 30 days before deserting the clutches that did not hatch out. Similarly, during the present study at Poona in three nests of *Corvus macrorhynchos*, in which the eggs did not hatch, the incubation went on for 28 days, 31 days and 32 days before desertion ; whereas at Vellore in 1956 (Lamba, 1965 : 430) one pair of this species

was found to incubate for 29 days before it gave up a clutch that did not hatch.

In a few other passerine species too, it has been noticed that the birds tend to incubate longer, about twice the normal period, before they desert the clutches that fail to hatch (Emlen, 1941, 1942 ; Nice, 1943 ; Berger, 1953 ; Sowis, 1955).

The young

The young of both *Corvus splendens* and *Corvus macrorhynchos* hatch out one after the other at intervals of 24 hours or so, more or less in the order in which the eggs are laid. The first and second eggs in *C. macrorhynchos* may sometimes hatch on the same day at an interval of not less than 12 hours. It has been suggested by some workers that this hatching of eggs over a period of several days, aids in protecting the clutch and brood from predators (*see* Van Tyne and Berger, 1959 : 294) ; but Lack (1947 : 325) believes that it is an adaptation "to bring brood size and available food supply into correspondence" The hatching success of *Corvus splendens* and *C. macrorhynchos* works out as 93.5% and 80.2% respectively at Poona whereas at Vellore it was 86.9% (Lamba, 1963a : 128) and 80.8% (Lamba, 1965a : 431) respectively. A comparatively higher rate of hatching in *C. splendens* is perhaps a natural selection to survive the loss of young on account of parasitisation by the koel.

The nestling of both the species of crows studied are nidicolous. The colour of the mouth cavity and the tongue of nestlings in both the species is bright red and presumably serves the same purpose as the elaborate directive marks of the mouth cavities of some of the other species (Swynnerton, 1916).

The average daily gain in weight during the first two weeks by four nestlings each of *Corvus splendens* and *C. macrorhynchos* is more or less their own weights at the time of hatching.

Although there is a marked difference in weights of the various nestlings of a brood on account of asynchronous hatching, it does not make any substantial difference in the general development of the body. Both in *Corvus splendens* and *Corvus macrorhynchos,* the eyes open on the 5th/6th day, the feathers cut the skin on 6th day and the fear complex develops in the 2nd week. 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 at Poona for *Corvus splendens* is 26 to 31 days (average 28.5 days). From Vellore also it has been recorded as 4 weeks (Lamba, 1963a : 130). The length of the nestling period at Poona for *Corvus macrorhynchos* is 31 to 36 days (average 33.65). 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 periods 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

The nesting success of *Corvus splendens* at Poona is found to be 54.7%, that is, about the same as reported from Vellore (Lamba, 1963 : 130). The nesting success of *Corvus macrorhynchos* at Poona is noticed to be about 62%, whereas from Vellore (Lamba, 1965a : 431) it has been recorded as 66%. The difference in the percentage of the nesting success in the two places is obviously a result of lesser nestling mortality at Vellore in that particular year.

Brood parasitism by Indian Koel

The koel, *Eudynamys scolopaceus,* lays mainly in the nest of *Corvus splendens* and occasionally in the nest of *Corvus macrorhynchos.*

Strategy employed in egg laying

Dewar (1906) was perhaps the first ornithologist to propound the theory that the male and female koels employ a well-planned strategy to lay in the nest of the ever-vigilant House Crow. He (Dewar, 1909 : 219-220) wrote :

"Needless to say, the Indian grey-necked crow is not the bird to be bluffed out of its nest by an ass in a lion's skin in the shape of hawk-like cuckoo. If the hen-cuckoo went up threateningly to a crow and tried to enter the nest, the crow would probably remark, 'Very sorry, ma'am, full inside, try outside' It therefore becomes necessary for the koels to resort to

artifice. The female, who is inconspicuously coloured, remains in the background, while the showy black cock bird swaggers up to the crow's nest upon which the pair have designs. As a rule, the sight of an adult male koel drives a crow almost mad with fury.

"Nothing is commoner in India than the sight of a couple of crows chasing a koel. Indeed, the cuckoos are most unpopular with birds of all classes. They are the outlaws of the bird world ; so they usually keep well to cover. When they do venture into the open they usually make a wild dash, like that of a boy from one 'base' to another when playing at rounders.

"Upon this occasion, however, the koel turns his unpopularity to account. If the sight of him is insufficient to provoke the crows at the nest to give chase, he begins to insult them. 'Call that thing a nest ?' he says mockingly. 'Why, if I could not raise up a more respectable structure than that I would lay my eggs in some other bird's nest' The crows, of course, will not tolerate this kind of thing. They give chase.

"Now, in a race between a koel and a crow the latter has about as much chance of winning as cart-horse would have if pittied against a Derby winner. The koel, however, is content to keep just ahead of his corvine pursuers; thus he lures them from the nest, and meanwhile his mate is placing her egg in it. When the male bird hears his wife's voice he knows that the foul deed is done, and so puts on a spurt and leaves his pursuers far behind, screaming as he disappears from view : 'Get back to the nest, you blockheads, the eggs are getting cold'

"The crows realise that this is really their most sensible course. On their return they fail to recognise the prank which has been played upon them; and so hatch out the strange egg along with their own. But the curious thing is that when the young koel is hatched, its foster-parents do not wring its neck, but tend it most carefully"

Since then numerous other workers, like the author (Lamba, 1963 : 131) preferred to accept this theory on circumstantial evidence. However, Dharmakumarsinhji (1954 : 136) has observed the actual act of the female koel slipping in the crow's nest when the owners were busy chasing the male koel away. But, during the present study, I have observed the female koel laying in the nests of both the species of crows at the grey dawn, taking advantage of poor visibility and temporary absence of the incubating female, without any help whatsoever from the male.

These observations coupled with my earlier observations induce me to believe that :—

1. The koel has no definite and well worked out strategy to dupe the crows. The female koel takes advantage of every possible temporary absence or distraction of crows from their nest to lay her egg, making full use of her colour which harmonizes with the surrounding at early dawn to accomplish the act. She is equally alive to the chances offered by crows while they are actively chasing another male or female koel during the daytime.
2. The House Crow hates the sight of both sexes of the koel because they sometimes catch the female redhanded entering the nest, and because of poor visibility of the early dawn they are often confused about the colour, that is, of sex of the intruder. Unforgetful as the House Crow is it never fails to chase away any koel, male or female, found in the vicinity of it's nest thereafter.

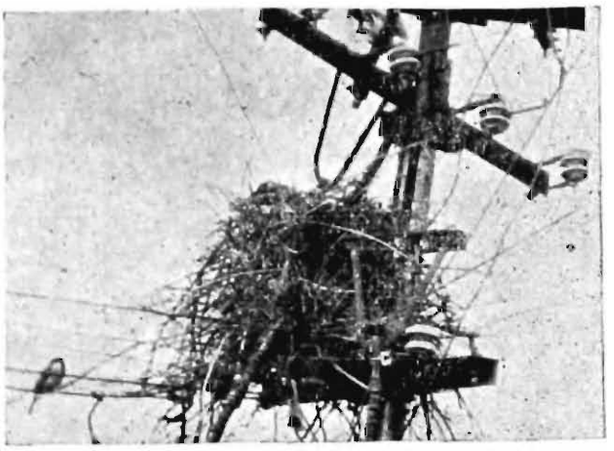
My belief is further strengthened by the following facts and reasoning :—

1. Although practically sixty years have passed since the strategy theory was first advocated (Dewar, 1906 : 219-220), not a single ornithologist, with the possible exception of Dharmakumarsinhji (1954 : 136, who mentions about seeing a "pair of crows chasing a male koel while the female entered the nest" but does not say if they were of a pair) has been able to confirm it by actual observation.
2. The authors of the strategy theory have taken it for granted that the House Crow hates the sight of the (male) koel without giving any specific reasons, presumably assigning it to instict. Had it been so, how the female koel who does not provoke the crows gets so often (Hume, 1890 : 393; Anderson in Hume, 1890 : 394; Butler in Hume, 1890 : 395 ; Dharmakumarsinhji, 1954 : 136 : MacDonald, 1960 : 131; Lamba, 1963 : 131) assaulted by the House Crow ? or, how is the Jungle Crow who does not go after the koel gets duped ? I wonder how far it will be correct to assume that the nature that has been kind to one species of host (House Crow) by bestowing upon it this useful beneficial instinct of hatred for parasites has been unkind to the other species of host (Jungle Crow) by denying the same to them. On the other hand,

it is logical to assume that this hatred or dislike or animosity is due to the inherent cunningness, vigilence and unforgetfulness of the House Crow (who often catch a koel redhanded entering the nest and never forget to chase any when seen afterwards) and due to a partial absence of these qualities in the Jungle Crow.

3. Birds generally prefer to lay in the mornings. Since the koel becomes active very early in the mornings, it is only natural to assume that they prefer to lay very early in the moning. This time of laying also help them in successfully camouflaging their actions.

It has also been suggested by a number of earlier workers that the koel removes one of the crow's eggs at the time of laying its own or subsequently if it gets the opportunity. Butler (one of Hume's correspondents) was perhaps the first to suggest such a possibility. He (Butler in Hume, 1890 : 395) writes : "When the hen bird lays she often turns some of the crow's eggs out of the nest, as I have several times examined crow's nests and found three or four eggs one day, and on examining them a day or two later have found some of the crow's eggs missing and koel's eggs in their place." Dewar, a quarter of a centuary later conducted a number of experiments to study and establish the parasitic nature of the koel. He (Dewar, 1907 : 781) states : "I consider it proven that the koel undoubtedly destroys or tries to destroy some of the crow's eggs it finds in the nest. My idea is that given the opportunity, the koel will destroy all the crows eggs. Unfortunately there was so much tempering with the nest that came under my observations that the evidence on this point, and indeed on most points, is not so conclusive as I could wish." Baker (1934 : 359) also obliquely suggests the same by saying : "Also from watching certain crows nests I know that where one day there have been so many crow's eggs, the same day later there has been one crow's egg less and one koel's egg more though this was not always the case." Although I have been thrice a witness to the actual laying of the koel yet, not even once, have I seen the koel removing or destroying any of the crow's eggs at the time of laying her own. The argument that it did not possibly have sufficient opportunity at the time of laying and might have destroyed one or more of crow's eggs afterwards is effectively countered by subsequent observations of all the three nests where no eggs were missed and the koel's questionable ability to differentiate her own eggs



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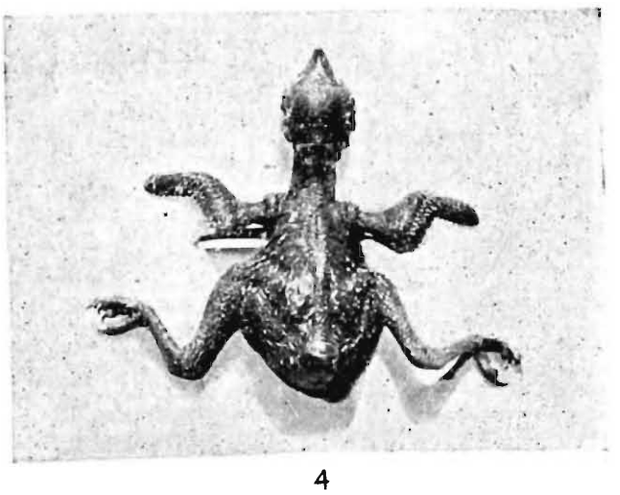

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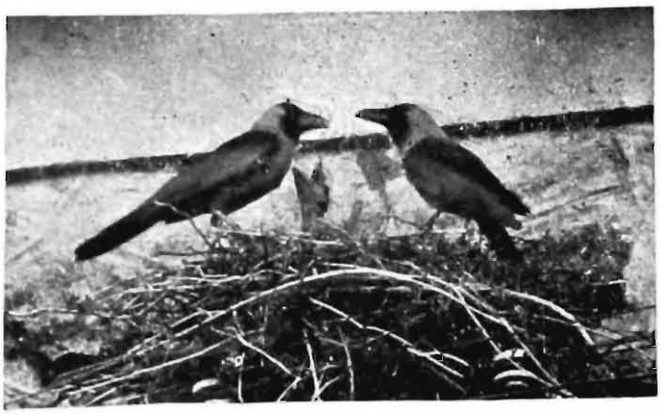

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Fig. 1. The house sparrow, *Passer domesticus* (Linnaeus) perching near the crow's nest. Fig. 2. Parent house crows feeding the nestlings. Fig. 3. The house crow appears to announce its territory. Fig. 4. About 72 hour old house crow nestling. Fig. 5. Male house crow staying near the nest on guard duty during incubation. Fig. 6. The jungle crow nest on a vertical fork of a tall tree.

(which she does not even see at the time of laying or immediately afterwards as she is an infernal hurry to get away) from that of the crow's at subsequent visits. I am, therefore, of the view that the koel does not tamper with the contents of crow's nest at the time of laying her egg. Taking into consideration the difficulties the female koel has to surmount for laying, subsequent visit to the same crow's nest to destroy crow's egg is an extremely remote possibility. The disappearance of one or more of crow's eggs from a nest under observation is more often than not the act of some urchin of the locality who happened to be a witness to one of the ornithologists's regular visits.

Nestling behaviour

The young koel, unlike other young cuckoos, does not eject the eggs or young of the host-species. This fact was recorded as early as 1907 by Dewar. The only unfair advantage the young koel takes is that it emerges a little earlier than its foster brethren and by the time they hatch out she is already big enough to raise its neck oftener and higher to draw the attention of the foster parents as they arrive at the nest with food. The young koel seems to have an insatiable hunger and goes on greedily devouring large percentages of the food brought by the crows, depriving the young crows of their legitimate share of the much needed nourishment during the critical first week. As a result, all but one, occasionally two, young crows die of starvation when their parents are fostering a koel nestling. When the number of young koels happens to be two rarely does a young crow survive.

Parent koel's behaviour

The koel, after having laid her egg in a crow's nest, forgets all about it. The common belief prevalent in the Punjab that the koel keeps in the vicinity of the nest in which it has laid and takes charge of its young as soon as it leaves the nest, has so far found support only from Hume. He (Hume, 1890 : 393) writes "One curious fact remains to be noticed. I have never seen crows feeding fully fledged koels out of the nest, whereas I have repeatedly watched adult female koels feeding young ones of their own species. I am pretty nearly convinced that after laying their eggs the female keep somewhere about the locality and take charge of the young directly they can leave the nests."

However, no subsequent worker, including myself, have ever come across an adult female koel feeding a young koel. Dixit (1968) has however suggested such a possibility on the basis of a single accidental observation of a female koel approaching a House Crow's nest, with grown up young, holding an insect in its beak. He also observed the female koel feeding push them out of the nest.
the largest nestling and pecking the other nestlings trying to

SUMMARY

1. The crows are selected for study on account of their close association with man amounting to virtual parasitism.

2. Koel is included in the studies because of its brood parasitism on crows, the main subjects of study.

3. Previous work on the breeding behaviour of the three species is traced right from 1862 to date.

4. The study was conducted in nature in and around Poona. Some birds were caught with mist nests and marked (ringed) for specific observations. Observations were made from improvised canvas hides and interior of parked vehicle. Nesting activities were watched through field glasses.

5. Contents of the nests were observed by climbing the nesting tree or reaching the nest by a bamboo ladder ; and with the help of tree climbers.

6. Selected nests were visited at regular intervals for specific observations.

7 Some nests, eggs and young were brought to the laboratory for recording descriptions, measurements, weights, etc. Vernier callipers was used for taking measurements of the eggs. For weighing eggs and young, analytical balance was used in the laboratory, and letter balance in the field.

8. The area of study (Poona) is situated on the northwest of Deccan Plateau, east of the Western Ghats on latitude 18°30 north and longitude 73°53 east at a height of 490 metres above MSL, on the banks of the Mula-Mutha rivers. It enjoys a mild, pleasant and invigorating climate with a large diurnal range of temperatures. It has three marked seasons : *cold*—November to February, *hot*—March to May, and *wet* June to October.

9. The monthly mean of daily minimum temperature at Poona ranges from 11.7°C. in December-January to 23.1°C. in

June, while the mean of daily maximum ranges from 27.6°C. in August to 38.3°C. in April.

10. South-west monsoon is the main source of rainfall at Poona. Average annual rainfall is 26.49" (662.25mm.). Humidity rises in May and June at Poona.

11. Poona gets westerly breeze throughout the year except October which is a month of variable winds, from November to February it also gets easterly breeze during the day. Poona gets the evening WNW sea-breeze also from February to mid-May. Thunder-storms occur in Poona in the months of April-May, morning fog (occasionally) and the dew appears from October to February.

12. Both the House Crow and the Jungle Crow breed at Poona annually for short durations of $3\frac{1}{2}$ to 4 months (*C. macrorhynchos* from end of February to middle of May and *C. splendens* from late April to early July). Some earlier workers have recorded both these species breeding twice a year in other parts of the country.

13. The Jungle Crow starts breeding by the end of February when the days are lengthening and the temperature is increasing at Poona. The House Crow starts breeding by the later half of April, *i.e.*, at the height of the hot season and when the relative humidity is increasing.

14. Both the species of crows breed during the period when suitable food for their young is in abundance.

15. Both the species of crows and the koel pair up annually only for the short duration of breeding season. The pair formation takes place before the territory is established.

16. Crows recognise their own species by association with the parents.

17. The recognition of species in koel is hereditary.

18. Crows recognise their mates at nesting stage, through visual and auditory cues.

19. The sexual bond in crows is absolute whereas in koel it is promiscuous.

20. Courtship in both the species of crows involves several characteristic behaviour like head tickling, billing and spooning.

21. Copulation in crows usually takes place inside the territory and during the nest building and laying stages. It is performed in the normal bird fashion.

22. *Corvus splendens* sustains a territory which is inter-

mediate between the types B and C of Hinde's catagories. *Corvus macrorhynchos* keeps Hinde's A type of territory.

23. Both the species occupy the territory after the slection of the nesting site and defend it mainly for nesting site, nest, clutch and brood.

24. Size of the territory (area of defence) in both the crows varies from 0.5 metres to 200 metres according to the nature and type of intruder.

25. Whereas there is a well developed social defence in the House Crow, in the Jungle Crow only the two of a pair defend. The defence consists of warning or alarm calls, pursuit and attack.

26. The main function of the territory in crows is to afford protection to nest, eggs and young.

27 Normal nesting sites are forks in trees for both the species of crows. Other sites like telephone, telegraph and electric poles, brackets and wires ; ledges and nooks of buildings, etc., are unusal nesting sites selected for want of normal ones.

28. Whereas the female appears to have a greater say in the matter of selection of a site for nest in *Corvus splendens,* both the partners apparently have an equal say in the matter in *Corvus macrorhynchos.*

29. Normal nesting materials for both the species of crows consist of sticks, twigs and various types of vegetable and animal fibres like, roots, grasses, leaf strips, human and animal hairs.

30. Metallic strips and wires are sometimes used by the House Crow as substitutes on account of scarcity of the normal nesting material.

31. Both sexes (of both the species) collect nesting materials but the bulk of the construction is done by the female.

32. House Crow takes about 7-17 days to complete a nest. The Jungle Crow does so in 7-21 days.

33. The finished nest in both the species of crows is a broad, shallow cup.

34. Eggs are laid only after the completion of the nest by both the species of crows. As many as four days may elapse between the completion of the nest and laying of the first egg.

35. Both the species of crows lay one egg a day till the clutch is complete. Eggs are generally laid between 7 and 11 hours in the morning by both the species.

36. The eggs in both the species are broad oval, bluish green in colour with a variety of dark markings, like specks, spots, blotches, streaks, etc., which are more on the broader end.

37. The eggs of the Jungle Crow are larger and heavier than those of the House Crow.

38. In *Corvus splendens* the average annual clutch-size varied from 3.8 to 4.1. The average clutch-size was largest (4.3 to 4.4) in the second quarter of the breeding season.

39. In *Corvus macrorhynchos* the average annual clutch-size varied from 3.4 to 3.5. The average clutch-size was largest (3.6 to 3.7) in the first quarter of the breeding season.

40. In both the species of crows the colour (ground and markings), 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.

41. Second eggs in both the species of crows tends to be heavier than the first.

42. Both the species of crows are determinate layers.

43. Whereas the House Crow starts incubating in right earnest with the laying of the first egg, the Jungle Crow does not take it up seriously till the second egg is laid.

44. Both in *C. splendens* and *C. macrorhynchos* the female does the incubation for the most part.

45. The Jungle Crow female is often fed by the male while she incubates.

46. Period of incubation is 15 to 17 days in the House Crow and 17 to 20 days in the Jungle Crow.

47. Eggs hatch out, in both the species, one after the other, more or less in the order in which they are laid.

48. Hatching success during the period of study in the House Crow was 93.51%, and in the Jungle Crow 80.20%.

49. The young of both the species of crows are nidicolous.

50. The body colour of the newly hatched nestlings in both the species is pink, the eyes are closed and very faint traces of down are present.

51. The weight of hatchling in both the species is slightly less (0.3 to 0.8 gram) than the egg (from which they emerged) at the time of laying.

52. Eyes of nestling of both species open on 5th/6th day.

53. Contour feathers cut the skin on 5th/6th day in the nestlings of both the species.

54. Fear complex develops early in the second week in the nestlings of both the species of crows.

55. The nestlings of both the species of crows are fully fledged in about three weeks time.

56. In both the species both sexes bring food for and feed the young. The peak of feeding activity is reached on the 8th/9th day of hatching of the first chick and is maintained for 5/6 days. As the young grow and are capable of swallowing more and comparitively solid food the feedings become less frequent. Food consists chiefly of kitchen scraps, animal and vegetable matter.

57. Both sexes carry out nest sanitation in *C. splendens* and *C. macrorhynchos*.

58. Whereas the fledglings of *C. splendens* stay in the nest for 26-32 days, those of *C. macrorhynchos* stay for 31 to 37 days.

59. The nestling mortality in *C. splendens* is very high mainly because of starvation of young on account of koel's parasitisation. During the course of these studies it was found to be 41.4%. The corresponding figure for *C. macrorhynchos* was 23.3%. Starvation and predation were the main causes of mortality in the latter.

60. The koel parasitises both the species of crows, but chiefly *Corvus splendens*.

61. The koel breeds in Poona from mid-April to mid-July.

62. Pair formation apparently takes place only for the duration of the breeding season.

63. Courtship consists of the male chasing the female around tree tops and feeding her generally before or after coitus.

64. Paired up koels are promiscuous in their sex life.

65. Territory is claimed by the male.

66. Both sexes defend the territory but only against their own sex and own species ; opposite sexes are welcome in the territory.

67 Defence consists of warning calls, threat display and combat.

68. Although every possible temporary absence of the hosts from their nest is utilised by the koel for laying its eggs in their nest, generally they are laid very early in the morning, in grey dawn before sunrise when the night incubating female crow leaves the nest for a respite.

69. A maximum of three eggs are laid in a single nest of

the host. The eggs are laid only after the host has laid one or more of its eggs.

70. At the time of laying the koel does not carry away or destroy any of crow's eggs.

71. The koel's egg hatch out earlier, *i.e.*, in 13 days as compared to 15 to 17 days of the House Crow and 18-20 days of the Jungle Crow. Thus the young koel gets a start over its foster brethren and is always the healthiest occupant of the nest.

72. Koel nestling is nidicolous ; body colour is light brown, eyes are closed, and faint traces of down are present.

73. Koel nestling does not throw the eggs of fosters or its foster brethren out of the nest.

74. Koel nestling stays in the nest for about four weeks, and follows its foster parents for a while even after leaving the nest.

75. Parent koels do not take any interest in their egg or young after egg has been deposited in a crow's nest.

76. Incidence of parasitism by the koel was found to be about 10% in the House Crow and 0.5% in the Jungle Crow during present study.

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