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Navdeep Singh, Navjot S. Sodhi and S. Khera

Zoological Survey of India, Calcutta

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BIOLOGY OF THE CATTLE EGRET *BUBULCUS IBIS COROMANDUS* (BODDAERT)

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1. INTRODUCTION

Voous (1960) has included the Cattle Egret under the faunal type Indian-African i.e., belonging to the fauna which is now largely discontinuous geographically but in late Tertiary and Pleistocene might have extended continuously from South Asia to North and Central Africa. Range expansion of this species from Africa to South America and then to North America, and also from Asia to Australia and New Zealand has created a great interest in the past many years. The biological success of this species in different continents, its feeding association with cattle and being a bird of agricultural importance have made it a favourite of ornithologists.

The Cattle Egret, *Bubulcus ibis* (L.) is a polytypic species having three subspecies. Nominate subspecies, *Bubulcus ibis ibis* (L.), is found in Africa, Madagascar, South Europe, South America and North America. Subspecies *B.i. coromandus* (Boddaert), commonly known as Asiatic subspecies, occurs in Pakistan, India, other countries of Orient and in Australia. The third subspecies, *B.i. seychellarum* (Salomonsen) is found in the islands of Seychelles. Out of the three subspecies, adequate information on the biology of *B.i. ibis* is available. Exiguous studies have been carried out on the other two subspecies, with the result the information on these subspecies remains meagre.

In this monograph three major aspects of biology, viz. breeding biology, feeding ecology, and population density of the Asiatic subspecies, *B.i. coromandus,* are covered.

Various workers have carried out studies in different countries on the breeding biology of *B.i. ibis.* Almond (1955) has reported briefly on the displays of *B.i. ibis.* Lehmann (1959) has published a note on general feeding, breeding, and roosting habits of *B.i. ibis.* Fowler (1960) has reported the nesting sites of *B.i. ibis.* in New Jersey for the first time. Skead (1966) has described general breeding and non-breeding behaviour of *B.i. ibis.* Siegfried (1965, 1966a, 1971a, 1971b, 1972a, 1973), in a series of papers on *B.i. ibis* has discussed the status, first breeding age, moulting, nest material, breeding success, reproductive output, and development of chicks. Blaker (1969) has described the breeding and non-breeding behaviours in

B.i. ibis. Jenni (1969) has described the ecology of *B.i. ibis* and three other ardeids. Lancaster (1970) has reported behaviour of *B.i. ibis,* laying emphasis on courtship and agonistic displays. Hudson, Dawson, and Hill (1974) have described the growth of nestlings of *B.i. ibis* alongwith temperature regulation. Burger (1978, 1979) has analysed competition between nesting *B.i. ibis* and other egrets, herons and ibises. Such information on the Asiatic subspecies, *B.i. coromandus,* has remained obscure as no comprehensive research paper on its breeding is published so far.

Most of the literature on the feeding ecology of the Cattle Egret refers to the subspecies *B.i. ibis* (Kirkpatrick 1925, Chapin 1932, Kadry-Bey 1942, North 1945, Bevan 1946, Van Someren 1947, Vincent 1947, Goodwin 1948, Middlemiss 1955, Reid 1955, Haverschmidt 1957, Dawn 1959, Meyerriecks, 1960a, 1960b, Fennel 1963, Ruwet 1963, Skead 1963, Blaker 1965, 1969a, Cunningham 1965, Heatwole 1965, Reynolds 1965, Craufurd 1966, Siegfried 1966b, 1971c, 1971d, 1972b, 1973, 1978, Skead 1966, Martin *et al.* 1967, Burns and Chapin 1969, Jenni 1969, 1973, Snoddy 1969, Heintzelman 1970, Kuyt 1972, Dinsmore 1973, Fogarty and Hetrick 1973, Van Ee 1973, Herrera 1974, Grubb 1976, Schupp 1976, Custer and Osborn 1978, Dean 1978, Halley and Lord 1978, Andersen 1979, Taylor 1979, Thompson *et al.* 1982, and Scott 1984).

The works of Feare (1975) and Pomeroy (1975) refer to subspecies *B.i. seychellarum.*

Except for a few sporadic reports (e. g. Mason and Lefroy 1912, Hussain and Bhalla 1937, Kosugi 1960, Sodhi and Khera 1984), there are only three detailed studies on the food of *B.i. coromandus,* namely of Ikeda (1956), Mukherjee (1971) and McKilligan (1984). Ikeda (*op. cit.*) studied the food of this subspecies from Japan; Mukherjee (*op. cit.*) from Sundarban (India); and McKilligan (*op. cit.*) studied its food, and also made some observations on its foraging behaviour during breeding season in South-East Queensland (Australia). Jenkins and Ford (1960) reported foraging associates of *B.i. coromandus* during different months in South-Western Australia. Recently, Monga and Pandya (1984) published a note on the foraging behavious of this subspecies. The present work is a first comprehensive study on the feeding ecology of subspecies *B.i. coromandus.*

Reports on the location of heronries and population of the Cattle Egret have been sporadic. A worthwhile contribution on the location of heronries

of the Cattle Egret in South Africa is given by Siegfried (1965). Heather (1978, 1982) has given a good account of population of the Cattle Egret in New Zealand. In India, except for Singh and Sodhi (1985) no work on heronries and population densities has been reported.

2. STUDY AREA

For the study of breeding biology of *B.i. coromandus* a study area situated 30°44′ N to 30°49′ N and 76°42′ E to 76°45′ E, comprising five villages of the Union Territory of Chandigarh and 28 villages of the State of Punjab was selected. This area is located in the foothills of Shivalik at an altitude of 262 meters on the northern margin and 347 meters on the southern margin. Two seasonal rivers "Patiali Rao" and "Jainti Devi Ki Rao" traverse the study area flowing from north to south (Fig. 1).

The study area is mainly an agricultural tract. There are two main crop seasons in this area, the Kharif (June-August to September-December) and the Rabi (October-November to March-April). The main Kharif crops are maize and paddy. The main Rabi crops are wheat and potatoes.

Vegetation of Chandigarh and its neighbourhood is described by Sharma and Sharma (1966). The main trees in this area are *Mangifera indica, Acacia arabica, Dalbergia sissoo, Azadirachta indica, Ficus bengalensis, Ficus religiosa* and *Eucalyptus muricatus. Euphorbia nivulia* and *Ipomoea crassicaulis* are the common hedge plants in the countryside. The common bushy undergrowth of trees is comprised of *Carissa spinarum, Flacourtis indica, Adhatoda vasica, Murraya koenigii* and *Lannea coromandelica.* The common climbers are *Ichnocarpus frutescens* and *Coccinea cordifolia.* Perennial grasses *Sacharum bengalense, S. spontaneum, Dermotachya bipinnata, Cynodon dactylon, Dichanthium annulatum, Cenchrus pennisetiformis, Sorghum halepense* and *Imperata cylindrica* are prominent, found in watery places.

During 1983 three ardeid species, viz. *Bubulcus ibis coromandus, Ardeola grayii,* and *Egretta garzetta* were breeding in the study area. In 1984, however, the only heronry of Little Egret (*E. garzetta*) was felled at Tira village, leaving the other two species to breed in the study area. There were eleven heronries of *B.i. coromandus* during the year 1983 in the study area, (Fig. 1), but two heronries were deserted due to human disturbance and four heronries were felled, thus leaving only five functional heronries.

There are five main seasons in this area, viz. Spring (February-March), Summer (April-June), Rainy season (July-August), Autumn (September-October) and Winter (November-January).

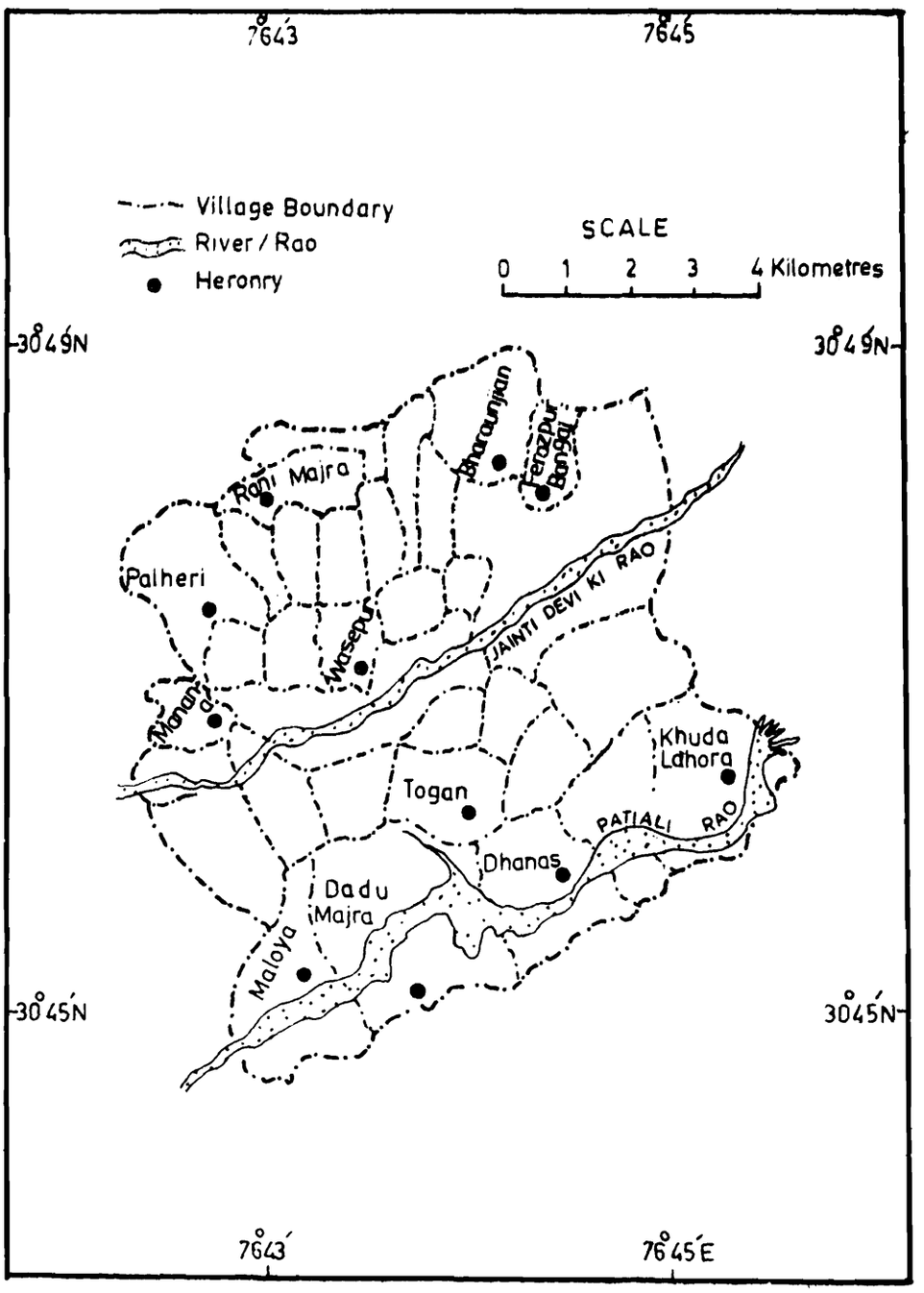


Fig. 1. Map of the study area.

During the breeding season of *B.i. coromandus* the maximum temperature was 43.8°C in the month of June, 1983 and 45.8°C in the month of May, 1984. The mean minimum and maximum temperatures during the breeding months are given in Table 1. Relative humidity is generally higher in July, August and September because of the onset of monsoon, but in the earlier months of May and June it is usually low. The rainfall starts with the onset of south west monsoons in this area. The rainy season starts in July with occasional pre-monsoon showers. The mean rainfall in the months of breeding season of *B.i. coromandus* is given in Table 1.

All observations on the feeding ecology of the Cattle Egret were made in 1984 and 1985, in and around Chandigarh. Study areas for the population studies are explained in 6.1 and 6.2 where they are more relevant.

3. MATERIALS AND METHODS

For the study of breeding biology of *Bubulcus ibis coromandus,* a hide, seven meters high was constructed at Bharaunjian colony for close-range observations and photography. Observations in other heronries were taken from the roofs of village houses near the heronries.

Agonistic and courtship displays were recorded following Focal-animal sampling described by Altmann (1974). The displays were photographed with a 16 mm. movie camera at a speed of 64 frames per second. These films were analysed frame by frame and figures were drawn from them. The analysis of displays is based on Hinde (1955), Tinbergen (1959), Baerends and van der Cingel (1962), Blaker (1969a) and Lancaster (1970).

Nests were marked with small squarish pieces of white cloth numbered with black water-proof ink. Bamboo and iron-ladders were used to climb the trees. As the branches became slippery in the rainy season, football goal-keeper gloves were used for ensuring grip. Due to thorny nature of nesting trees of *Acacia arabica* a machete of tempered iron was used to slash branches for making way to nests. Motor-cycle glasses were used for the safety of eyes from thorns and from forward stabs of nestlings. Yellow-wasp (*Polistis hebraeus*) was a nuisance for study because it made nests alongwith egrets. The wasp nests were removed with a torch-flame. A long stick and a measuring-tape were used for taking nest heights and maximum height of trees, while climbing on nesting trees. For the study of nest material, nests were removed after the nestlings attained the age of 30 days. These nests were taken to the laboratory where the measurements and weights of twigs were taken.

Table 1: Temperature, relative humidity and rainfall in the breeding months of *B.i. coromandus* during 1983 and 1984 (data from Meteorological Department, Chandigarh)

Year	Month	Temperature (°C)				Relative humidity (%)				Rainfall (cm.)	
		Maximum		Minimum		Maximum		Minimum			
		Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
1983	May	26.4-39.6	34.6	17.8-24.5	21.4	47-100	76.0	14-67	36.0	0.5-53.1	13.6
	June	33.0-43.8	38.4	20.0-28.3	24.2	44-97	68.5	8-53	27.6	0.1-40.8	9.6
	July	25.7-40.3	34.9	22.5-29.8	25.1	73-100	88.3	38-82	55.4	0.4-89.9	24.8
	August	27.4-35.4	32.4	22.2-29.0	24.9	89-100	95.8	50-92	70.8	0.2-69.9	18.8
	September	26.6-36.6	32.2	20.0-26.7	23.5	85-100	93.6	51-85	64.4	0.7-26.6	8.6
1984	May	34.6-45.8	41.4	19.2-32.0	25.9	23-78	43.7	8-83	17.3	—	—
	June	22.2-45.0	36.7	21.7-34.4	27.2	41-100	74.0	17-68	43.2	0.1-47.0	13.3
	July	31.8-36.6	33.6	20.0-26.5	24.5	81-100	91.2	33-71	56.6	0.2-91.8	12.6
	August	29.5-37.0	33.0	23.6-27.3	24.6	82-100	92.0	46-83	66.3	0.1-22.4	7.0
	September	28.6-34.4	32.0	16.7-25.0	21.5	68-100	91.2	38-80	58.4	0.1-43.8	16.5

Of the pair, one bird was marked with "eosine-red" with a colour-marking device for nesting birds, as explained by Mosley and Mueller (1975), for determining sex of egrets during incubation and afterwards.

Nests were visited daily after start of egg-laying. Eggs were lowered in a polythene-bag and marked with instant colour pens for determining laying pattern and incubation period. For the monthly variation in clutch-size the clutches have been considered to belong to the month when the laying started i.e. if the egg-laying started in May and clutch was completed in June, in the present study it was considered to belong to the month of May. Incubation period described in the study means the number of days from the laying of the last egg to the hatching of that egg (Nice, 1953). Length and breadth of eggs were measured with a vernier calliper. The eggs were weighed with a sensitive spring-balance. Eggs incubated naturally for 20-21 days were taken to laboratory and their hatching was observed and photographed. The eggs that failed to hatch were dissected for knowing the cause of their failure.

Nestlings were lowered in polythene bags. Descriptions of their morphology was entered at the same time. The colour terminology is based on seven prismatic spectrum colour divisions alongwith black and white. Other terms such as sky-blue, sea-green, horny and fleshy are used in order to make things more clear. The method for measurements of nestlings is after McVaugh (1975).

Body length: from the tip of the bill to the tip of the longest rectrix with neck extended.

Wing length: from the distal bend to the longest primary (primary flattened and stretched).

Wing length (extended): across both extended wings from tip to tip.

Bill: the upper mandible from the base of the exposed culmen to the tip.

Tail: the longest rectrix from its insertion in the follicle to its tip.

Tarsus: from the middle of joint between the tibiotarsus and tarsometatarsus to the lower edge of the lowest undivided scute on the front of the junction of the tarsometatarsus with the base of middle toe.

Middle toe: from the junction of the middle toe with the foot to the distal end of the toe, excluding claw.

Weight of nestlings was taken with 500 gm. pan-balance. The nestlings were ringed to mark different siblings and for noting nestling period.

The Cattle Egrets were watched for at least 200 hrs, to observe their foraging behaviour and to note the habitat, by Focal-sampling method (Altmann 1974). The terminology of different foraging behaviours has been adapted from Kushlan (1976).

A total of 95 food samples, collected between March 1984 to March 1985, were examined. A minimum of two samples were obtained each month. Two methods were used to collect food samples. Firstly, live egrets (45) were shot, after at least one hour of feeding. Secondly, regurgitated food samples (50) from nestlings were obtained. The nestling Cattle Egrets disgorge when alramed, like other herons (Lowe 1954, Owen 1955, Fasola *et al.* 1981). The older nestlings 15-30 days of age; readily vomited, but younger nestlings(< 15 days of age) were either shaken gently or their abdominal area was massaged to provoke vomiting.

The collected samples were preserved in different percentages of formaldehyde, depending upon their nature. All collected samples were labelled with an individual allocated number, date, time of day, locality, and habitat (in case of stomach contents). Samples were analysed as soon as possible. Before analysing, each sample was freed of sand and plant debris (if present). Thereafter, food sample was spread between the sheet of blotting paper. to remove surplus moisture. Each food item was then identified, measured (if measurable), and weighed separately or in groups (if belonging to same group) on an electrical balance. The number of different food groups, e.g. *Chrotogonus* sp. or *Acridium* sp., present in each sample, was also counted. The analysis of each sample was noted on separate sheet(s), so that in the end total number of a particular food group, and its occurrence in different food samples could be noted.

The data are presented (in Table 38), as percentage, of total wet weight of food, of number of total food items and of frequency of occurrence. Since there is no difference between food consumed by adult herons and that fed to young (Owen 1955, Kushlan 1978, Fasola *et al.* 1981, pres. obs.), so both regurgitated and stomach samples are combined in the table.

Two areas were selected for population study. One was the Union Territory Chandigarh. The other was the Punjab State from which four quadrats of 10 × 10 sq. kms. were selected. Surveys of these areas showed that the breeding season of *B.i. coromandus* starts in the first week of May and terminates in mid-September. During the month of July the formation of new nests stops. The census of heronries/breeding bird census was made from mid July onwards. Method of census was adapted from Kendeigh

(1944). During the census of heronries, surveys were made on bicycle, scooter or on taxi. Active nests of *B.i. coromandus* were counted and were entered in the field book alongwith the species of the nesting trees and type of heronries. Heronries were classified following the system described in 4.41. For Christmas counts, the roosts were located by following the roostward flights of egrets with the help of a compass. The counting was made on the roosts where incoming egrets were counted.

4. BREEDING BIOLOGY

4.1 BREEDING SEASON

In case of *Bubulcus ibis coromandus* there is a single, annual, breeding season starting in the first to second week of May and terminating in the first to second week of September. Ali and Ripley (1983) have described a single breeding season of *B.i. coromandus* in Indian subcontinent varying in periodicity, June to August in northern India, November to February in South India and February to July in Sri Lanka. Ganguli (1975) has reported the breeding season of *B.i. coromandus* from May to August in New Delhi. Blaker (1969a) has described a single annual breeding season of *Bubulcus ibis ibis* in South Africa. However, Lowe-McConnell (1967) has reported two breeding seasons of *B.i. ibis* per year in Guyana, South America.

4.11 DURATION OF BREEDING SEASON

The breeding in case of *B.i. coromandus* is asynchronous. Due to the asynchronous breeding, the colony always has a longer breeding span than the individual egrets. During 1983 and 1984, it was observed that the time taken by individual egrets from the day of pair-formation to the day when last fledgling left the nest permanently, was 84.14 days (mean of 50 successful pair-histories) with a range of 81-101 days, while the mean breeding span of five colonies was 124 days with a range of 110-134 days.

4.12 INITIATING FACTORS

The period from May to September is marked by the emergence of insects, amphibians, reptiles, and earthworms thus offering maximum food-supply to the egrets during these months.

Increase in the day length between the two equinoxes of 21 March and 23 September, results in an increment to the foraging hours of the Cattle Egret. In the egrets shot during the last week of March, gonads had started increasing in size. The gonads were fully matured by mid-April.

In 1983 the heronry first occupied was that of village Ferozpur Bangal. The study of breeding biology was made at this heronry which resulted in disturbances to the latter because the nests, eggs and nestlings were marked; a daily visit was made in order to make notes and the nestlings and eggs were weighed. Moreover, one of the nesting trees of this heronry was also felled by the villagers. In 1984 this heronry was deserted after a few attemps to settle by the egrets. In 1984 Bharaunjian heronry was the first to be occupied; there was very little human disturbance and no pruning or cutting of nesting tree in this heronry during 1983.

The enlargement of gonads corresponds with the increase in the day length from March equinox to June solstice. The increase in day length and food seem to bring about the main physiological and morphological changes and hence initiate the breeding of this species. The colony with the minimum disturbance and minimum felled trees is occupied earlier than those where the disturbance and hewing of trees were greater in the previous year. The nesting conditions, therefore, influence the periodic occupation of colonies.

Ali (1979) has stated that the breeding season of *B.i. coromandus* varies with the rainfall in India. Lowe-McConnell (1967) has described two breeding reasons of *B.i. ibis* synchronizing with the two rainy season in Guyana, South America. In the study area the mean rainfall was 1.19 mm., 3.65 mm. and 13.5 mm. in the month of March, April and May respectively during 1983, the first establishment of colony was noted on 2 May (Ferozpur Bangal colony). While the mean rainfall was nil, 0.15 mm. and nil in March, April and May respectively during 1984, even then the first record of colony development was 4 May (Bharaunjian colony; Table 2). It can, therefore, be made out that although rainfall does help to supplement the food of *B.i. coromandus* by favouring high emergence of insects, amphibians, reptiles, and earthworms, it does not lead to the drastic food change, because the food elements are available in sufficient quantity for egrets to feed. The onset of breeding season could vary in the areas where the food is scanty and rainfall brings a drastic change in food elements.

4.13 DEVELOPMENT OF COLONIES

The development of colonies observed during the years 1983 and 1984 is given in Table 2. In all the cases, the development of colonies started with the roosting of a flock of the Cattle Egret in each heronry. One to three days of successful roosting (without human disturbance) at one particular colony

led five to ten males to stay during day time and acquire territories. These males started performing courtship displays which attracted females to attend them. The continuation of displays by males and females led to other temporal breeding sequences.

Table 2: Development of colonies during 1983 and 1984

Name of colony	Event	1983	1984
Ferozpur Bangal colony	First *B.i. coromandus* seen at nesting site	2 May	7 May
	First copulation observed.	7 May	14 May
	First egg laid	9 May	—
	Last egg laid	15 June	—
	Last egg hatched	9 July	Colony deserted
	Last nestling left the nest permanently	2 Sept.	
Dhanas colony	First *B.i. coromandus* seen at nesting site	13 May	Colony not occupied
	First copulation observed	17 May	
	First egg laid	20 May	
	Last egg laid	16 June	
	Last egg hatched	11 July	
	Last nestling left the nest permanently	5 Sept.	
Bharaunjian colony	First *B.i. coromandus* seen at nesting site	10 May	4 May
	First copulation observed	14 May	6 May
	First egg laid	17 May	9 May
	Last egg laid	19 June	21 June
	Last egg hatched	12 July	15 July
	Last nestling left the nest permanently	3 Sept.	7 Sept.

4.2 BREEDING TERRITORY

The breeding territory is acquired by male with the onset of breeding season. Male occupies an old nest or selects a new site for nest-building and starts defending that domain. From the onset of breeding season to the pair-formation stage, male is the solo defender of breeding territory. After the pair-formation takes place, both sexes stay together for few hours to one day and defend territory. During nest-building period before egg-laying, the male is on material collecting trips while the female, which remains most of the time on nesting site, defends the territory. During egg-laying, incubation and brooding, both male and female defend the territory alternately. After brooding the parents leave the nest for feeding trips and nestlings are the sole defenders of territory.

Out of the four breeding territories explained by Welty (1979), *B.i. coromandus* falls in the category of 'narrowly restricted nesting territory' i.e. the territory where birds defend the immediate surrounding of the nest. The minimum distance between the centres of two adjacent nests was 77 cm. at Bharaunjian colony. Blaker (1969a) reported a distance of less than 60 cm. between the centres of two nearest nests of *Bubulcus ibis ibis*. Above variation between the territories can be correlated with the size of colony. The colony where Blaker (1969a) worked had the number of nests in thousands whereas the colonies in the present study never exceeded 200 nests. It can, therefore, be stated that higher congregation of breeding egrets can lead to the minimum possible territory i.e. the sphere of distance between the centre of incubation patch to the tip of beak.

The threat display observed during territorial protection is Forward Display. This display is performed by both the sexes but before pair-formation only male performs this display because the female is dominated by fear and tries to flee from any kind of encounter. This display comprises the following components. The egret moves towards the intruder and gives a forward-stab by extending its neck, beak slightly open, wings half spread to fully open, crest feathers semi to fully erected and back plumes slightly raised (Fig. 2). A low "oon" call was associated with 12 out of 73 such displays observed in unpaired males. Blaker (1969a) reported the association of "Thonk" call with Forward Display of *B.i. ibis* but in *B.i. coromandus* the "thonk" call is associated with Downward Display (see 4. 321).

The biological significance of this display is to maintain individual distance. Hence it is the chief distance increasing display of *B.i. coromandus* which checks the intrusion by other individuals.

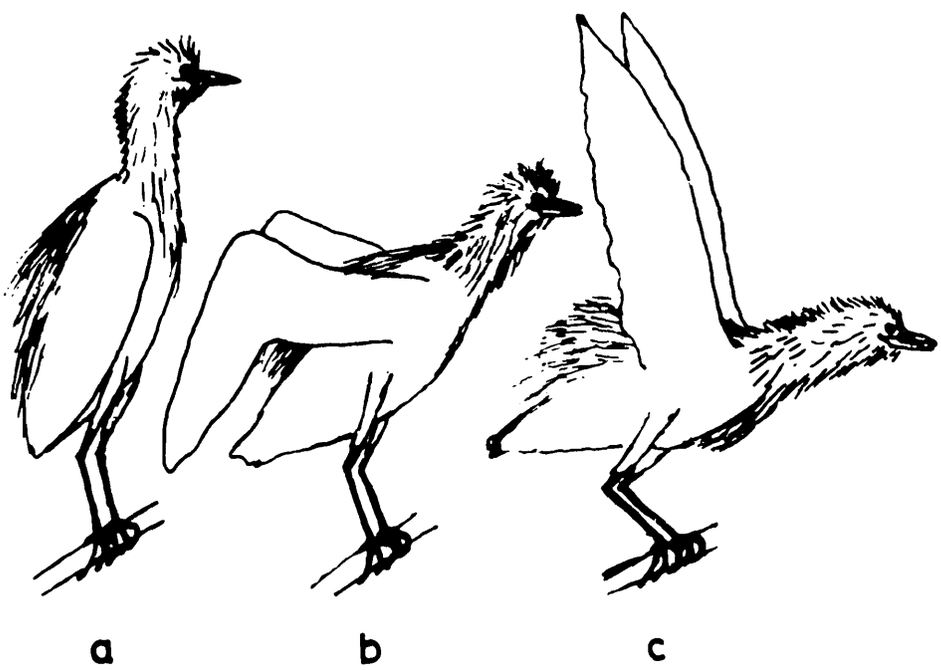


Fig. 2. A series of figures drawn from 16 mm. movie film showing Forward Display in *B.i. coromandus.*

4.3 COURTSHIP AND MATING

4.31 COLOUR CHANGE IN PLUMAGE AND SOFT PARTS

In *Bubulcus ibis coromandus* the buff-coloured plumage on head, neck and back starts appearing in mid-March that results in white and buff-coloured egrets in mid-April. Coloured plumage varies from individual to individual, resulting in vast individual variation. About 8% of *B.i. coromandus* population did not acquire breeding plumage and remained white. Vincent (1947) has reported the breeding of *B.i. ibis* at two years of age; at the age of one year it does not acquire breeding plumage. The present white population of *B.i. coromandus,* therefore, seems to represent one year old Cattle Egrets, though four of such individuals were observed breeding during 1984 at Bharaunjian heronry. None out of the four acquired breeding plumage yet their eyes and beaks were red. All these four individuals were females. Also, some white males were seen collecting sticks and making nests; none of these males were seen courting and

Plate 1. Different stances in male and female during courtship. Male having a hunched posture with its neck retracted (on left). Female having a peering stance with its neck extended (on right).

breeding successfully. Siegfried (1966a) reported the breeding of *B.i. ibis* at the age of one and the acquisition of breeding plumage as well. But this report could not be confirmed in the present study as the nestlings ringed during 1983 were not recovered the following year.

The colour of beak in *B.i. coromandus* changes from yellow to red. The lores change from yellow to magenta-violet. The iris changes from yellow to red. The colour of legs changes from black to red. But the egrets with yellow lores, beaks and greenish-yellow legs were also seen courting and making pairs. The number of such 'yellows' was very low as compared to the 'reds' The red egrets performed displays at a greater speed than the yellow ones and the females always preferred the red-males if two or many males of different colours were courting.

After pair-formation the red colour starts fading and within few days the egrets have yellow beaks and irises, and greenish-yellow legs.

4.32 COURTSHIP DISPLAYS

The males after acquiring territory start performing variety of courtship displays in order to advertise their readiness for pair-formation. During the period before pair-formation, the males and females can be easily differentiated on the basis of behavioural stances. The males are hunched with their breeding plumes semi-erected and perform high-frequency displays (Plate 1; Tables 3 and 4). The females have a peering stance with their necks half extended and perform overall low-frequency displays (Plate 1; Table 5). This behavioural difference in the males and females is also described by Blaker (1969a) and Lancaster (1970) in *B.i. ibis.*

4.321 *Downward Display*

This display is characteristic of unpaired males and ceases to occur after pair-formation. The Downward Display is never observed in females. This display comprises the stretching of neck during the perched position with beak directing downwards, plumes of head and neck are partially to fully raised, back plumes are partially erected, the neck is snapped down with the bobbing of body (Fig. 3), a characteristic "thonk" call is given with the downwards movement of neck in 613 (91.9%), out of 667 observed displays, former position is attained by raising and retracting the neck and also by straightening of the legs.

Blaker (1969a) described the absence of such display in *B.i. ibis* in South Africa. However, Lancaster (1970) reported this type of display in *B.i. ibis* without snapping of mandibles and without any vocalization in Columbia.

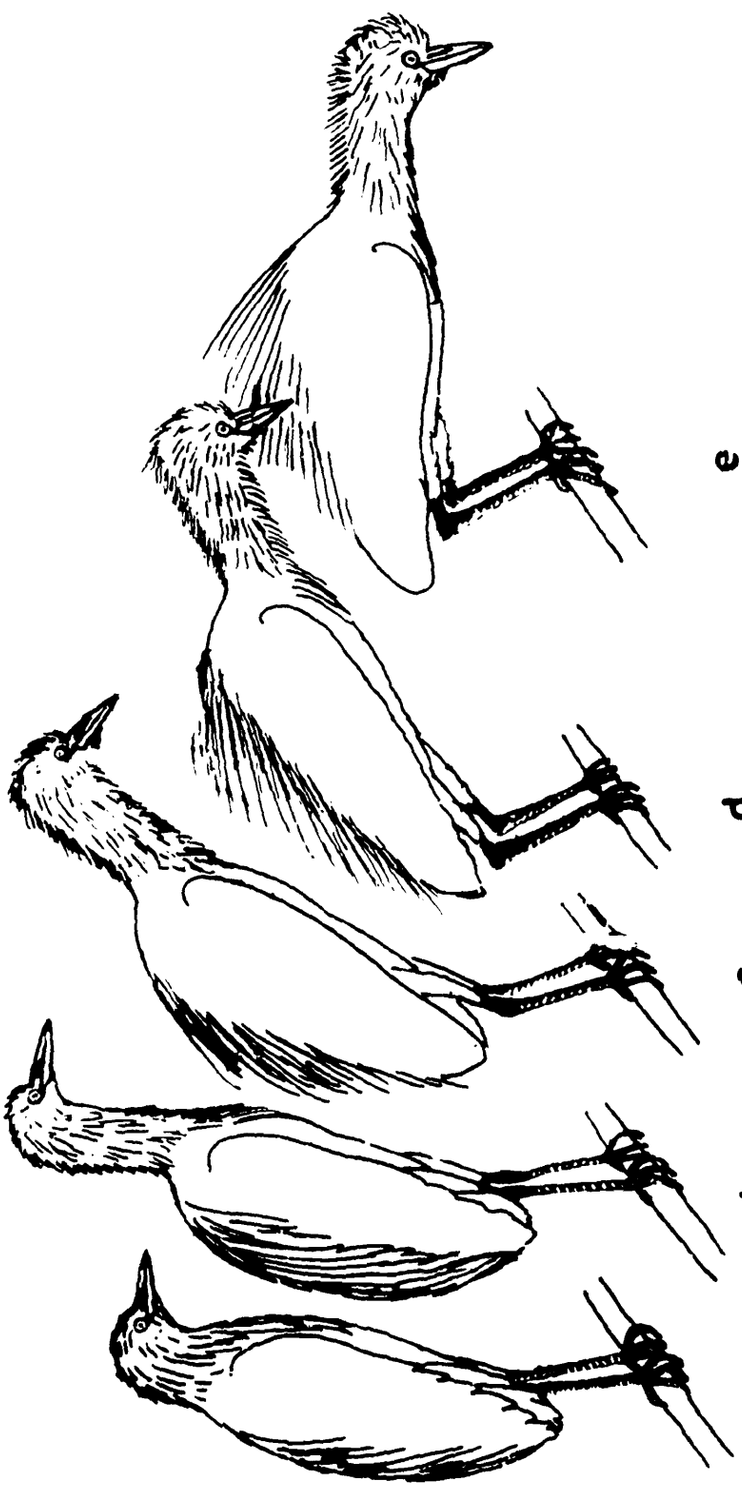


Fig. 3. A series of figures drawn from 16 mm. movie film showing Downward Display in *B.i. coromandus.*

Table 3: Frequency of displays in male *B.i. coromandus* in the presence of receptive females

Sample Time (minutes)	Number of individuals observed	Name of display	Number of displays observed in sample time	Rate per minute	Rate per hour	Frequency (%)
798	39	Downward Display	421	0.52	31.6	14.3
		Twig Shake	990	1.24	74.4	33.8
		Wing Touch	1183	1.48	88.9	40.4
		Stretch Display	183	0.22	13.7	6.2
		Flap Flight Display	18	0.02	1.3	0.6
		Forward Display	73	0.09	5.4	2.4
		Wing Spread	59	0.07	4.4	2.0
Total			2927	3.64	219.7	

Table 4: Frequency of displays in male *B.i. coromandus* in the absence of receptive females

Sample Time (minutes)	Number of individuals observed	Name of display	Number of displays observed in sample time	Rate per minute	Rate per hour	Frequency (%)
214	8	Downward Display	246	1.14	68.9	41.6
		Twig Shake	173	0.80	48.5	29.2
		Wing Touch	121	0.56	33.9	20.4
		Stretch Display	31	0.14	8.6	5.2
		Flap Flight Display	2	0.009	0.5	0.3
		Forward Display	5	0.02	1.4	0.8
		Wing Spread	13	0.06	3.6	2.1
Total			591	2.729	165.4	

Table 5: Frequency of displays in female *B.i. coromandus* in the presence of courting male

Sample Time (minutes)	Number of individuals observed	Name of display	Number of displays observed in sample time	Rate per minute	Rate per hour	Frequency (%)
		Downward Display	—	—	—	—
		Twig Shake	19	0.03	2.1	2.1
528	27	Wing Touch	762	1.44	86.5	86.8
		Stretch Display	9	0.01	1.0	1.8
		Flap Flight Display	87	0.16	9.8	9.9
		Forward Display	—	—	—	—
Total			877	1.64	99.4	

He classified this display as Downward Snap; a special kind of Forward Display. The Downward Display resembles the Snap display of other ardeids in stretching and downward snap of neck and also in the 'bob' component but differs from it in missing the essential snapping of mandibles on which the name 'Snap Display' is based. The Snap Display of Ardeidae reported so far has no call associated with it (Meyerriecks, 1960b; Baerends and van der Cingel, 1962; Blaker, 1969b; Mock, 1978; Wiese, 1979). The association of "thonk" call and absence of snapping of mandibles are the main characteristics which distinguish the present display from the Snap Displays of other ardeids. This is a new display being described for the first time in the Cattle Egret as well as in family Ardeidae. The naming of this display is after Tinbergen (1959). It can be stated here that natural selection of a particular display differs in different geographical regions resulting in the differences among the displays of the two subspecies or among the same subspecies, as is evident from the results of Blaker (1969a), Lancaster (1970) and the present study.

The primary behaviour pattern of this display resembles the first phase of feeding activity of *B.i. coromandus*. This phase comprises stretching of neck and downward snap alongwith bobbing of body. Therefore, this display seems to be originated from the displacement activity of feeding.

During Downward Display the breeding plumes are erected indicating aggression. The "thonk" call can be heard from a distance of approximately 50 meters. The display, therefore, seems to be the chief advertisement display of this species which serves a purpose of warning to other conspecifics and makes it easy for the females to locate the males in heronry.

4.322 *Twig Shake*

This display is performed by both sexes. The rate of this display is very high in males, 74.4 per hour,and is extremely low,2.1 per hour,in females (Tables 3 and 5). Both males and females continue to perform this display after few hours of pair-formation with a rate of 10.8 per hour in males and 7.5 per hour in females (Tables 6 and 7) but, thereafter, this display ceases to occur.

During this display the perched egret stretches its neck and holds a tree twig in its beak and shakes it sideways (Plate 2). After pair-formation Twig Shake is performed by the male even when it is standing on the female during unsuccessful copulatory attempts. The crest, neck and back plumes are partially raised during Twig Shake. Three positions of shaking twig,

Plate 2. An unpaired male performing Twig Shake by extending its neck and sideways shaking of twig.

above the level of abdomen at the level of abdomen and below the level of abdomen resulted in 228 (23.0%), 551 (55.6%) and 211 (21.3%) respectively, out of 990 observed Twig Shakes in unpaired males in the presence of receptive females. No functional significance can be attached to such positional variation, as the twig shaking mostly depends upon the availability of twigs. No vocalization was associated with this display. Blaker (1969a) has reported the association of 'nasal chatter' with 31% of Twig Shakes in *B.i. ibis.*

This display seems to be the ritualized twig breaking activity (push and pull). In low intensities this activity is performed without flapping of wings and with slow shaking of twigs.

Unpaired males in the absence of receptive females performed low rate Twig Shakes (Table 4) as compared to the unpaired males in the presence of females (Table 3). It can be suggested that this display is an advertisement display by which males show their readiness and competence for collecting nesting material.

4.323 *Wing Touch*

This display is performed by both sexes, the frequency being very high in unpaired females as compared to unpaired males (Tables 3, 4 and 5). Wing Touch is the chief display of females. This display continues for a few hours after pair-formation and then ceases to occur. Wing Touch comprises the bending of neck to one side and moving the slightly open beak down the wing bend (Fig. 4). The beak is moved on both left and right wings.

This display resembles the preening activity of *B.i. coromondus.* Wing Touch is the result of displaced preening activity which has been ritualized sufficiently to act as an advertising display in this case.

In 42 observed pair-formations it was noted that the female which performed high frequency Wing Touches was always preferred by male to form pair. In males this display occurred in the series of four displays performed in a constant environment. This display is, therefore, chief advertising display in females and also serves as important display in males. Blaker (1969a) describes Wing Touch in *B.i. ibis* as merely a displacement activity without any releaser function but in the light of present study it can be stated that this displacement activity in *B.i. coromandus* has been incorporated in the courtship behaviour as an advertisement display both in males and females.

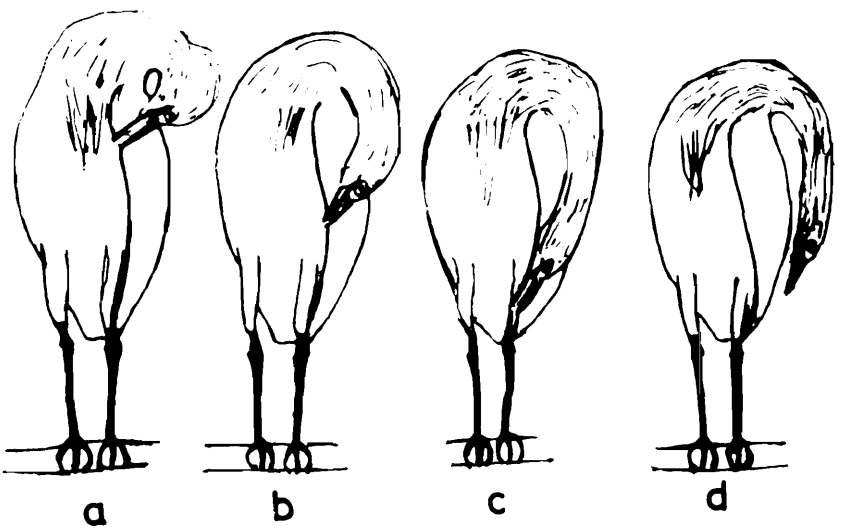


Fig. 4. A series of figures drawn from 16 mm. movie film showing Wing Touch in *B.i. coromandus.*

4.324 *Stretch Display*

This display is chiefly performed by unpaired males but is also observed in unpaired females in extremely low frequency (Tables 3, 4 and 5;). Blaker (1969a) and Lancaster (1970) have reported the absence of this display in the females of *B.i. ibis.* In the present study, however, the females *B.i. coromandus* were observed performing this display though with a very low frequency (Table 5). After pair-formation to the start of nest construction this display is performed by female with a high frequency (Table 7; Figs. 7 and 8). As the nest construction starts, the components of this display are also performed in the 'Greeting Ceremony', both by males and females.

This display comprises the stretching of neck upwards with head, neck and back plumes fully sleaked. The beak is directed upwards during the fully extended neck position. Then the retraction of neck is performed with the bobbing of body (Fig. 5).

During this display the organ of fight (beak) is directed upwards advertising the intention of the displayer not to fight. The display can be categorized as "distance reducing display"

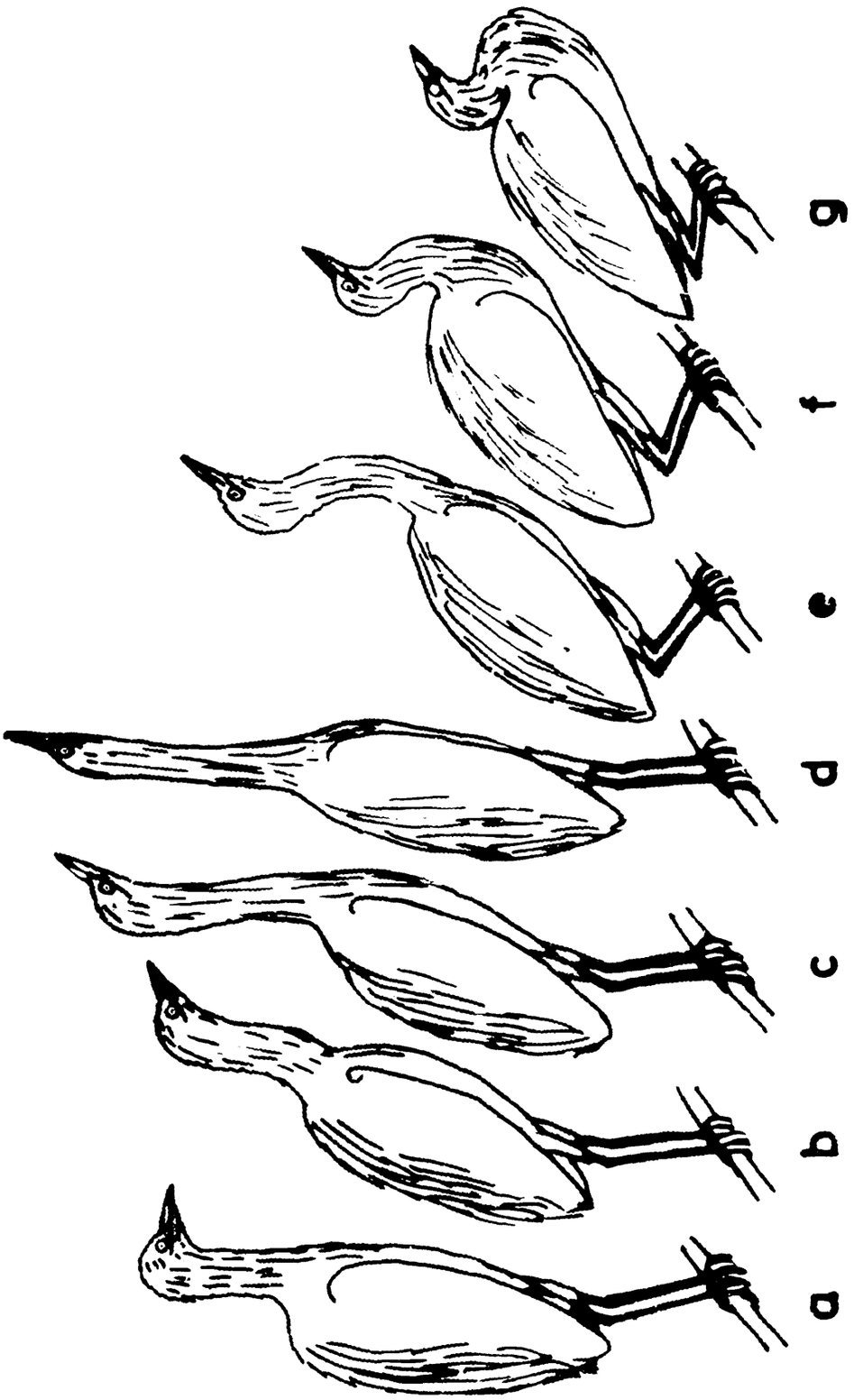


Fig. 5. A series of figures drawn from 16 mm. movie film showing Stretch Display in *B.i. coromandus.*

Plate 3. A male performing Flap Flight Display with dangling legs, half extended neck and cupped wings moving for down stroke.

4.325 *Flap Flight Display*

This display is performed by both sexes. The frequency of this display is higher in unpaired females than in unpaired males. The females stop performing this display after pair-formation while males continue with it a few days after pair-formation.

This display comprises 0.6-5 meters flight in the vicinity of nesting site. The flight is conspicuous in having a loud "thud" sound with each wing beat. The neck is partly extended, rectrices fully spread and legs dangle (Plate 3). The crest, neck and back plumes are semi-erected. Three to eleven consecutive "thuds" have been noted during this display.

Blaker (1969a) has interpreted that the Flap Flight Display of *B.i. ibis* has originated from the flight activity. In order to be more accurate it is made out that Flap Flight display is the result of ritualized landing flight of Cattle Egret. During landing flight the legs of Cattle Egret dangle, neck is half extended, tail feathers fully spread and amplitude of wing beats increases. On the other hand during normal flight the legs are directed backwards, the neck is retracted, the tail feathers are not fully spread and the amplitude of wing beats is low. It is found from the intensive viewing of the movie films that the sound of "thud" is not produced by the clapping of wings. When wings are moved for the down stroke, they are cupped and at the termination of the down stroke the air contained in these cupped wings is clapped,producing the sound of "thud"

4.326 *Wing Spread*

This display is performed by unpaired males and ceases to occur after pair-formation. During this display the male spreads its wings curving downwards, with the head,neck and back plumes semi-erected and neck half extended (Fig. 6). The male moves on branches with spread wings.

This display is ritualized balancing activity in which the wings are spread to maintain balance.

4.33 PAIR-FORMATION

The males start performing high-frequency displays after acquiring territories. Generally these displaying bouts were observed during 13.00-19.00 hours of the day, the time from morning to noon is spent on feeding. As the males start performing courtship displays, the unpaired females start attending the actively displaying males.One the four females were observed

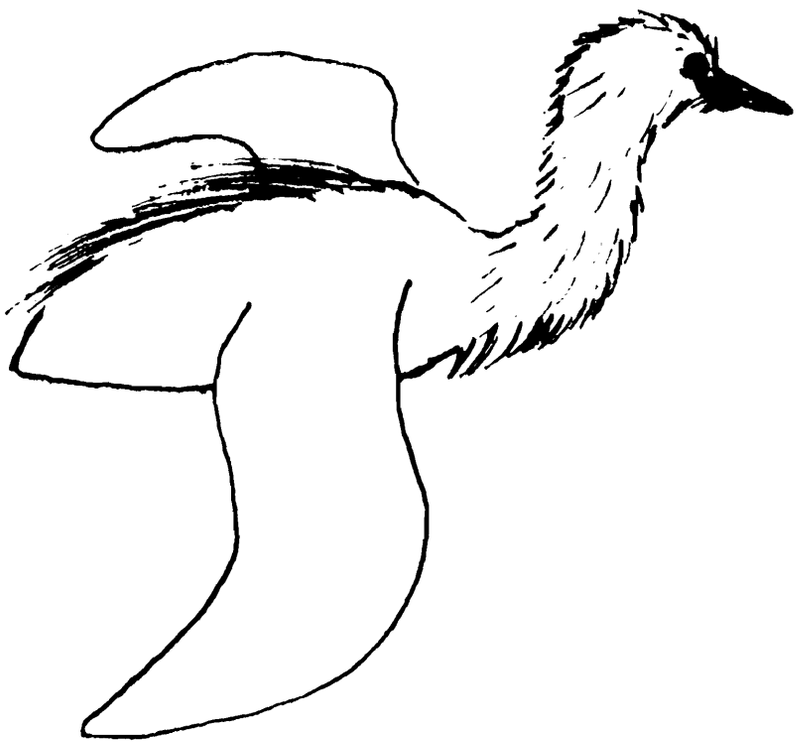


Fig. 6. Wing Spread in *B.i. coromandus.*

attending one such male at a time. The females continuously try to land on the back of male and are given strong Forward Displays by the latter. In some of the cases the males even pulled the back plumes of females during Forward Display. If more than one male are present, the more aggressive and more actively displaying male is attended by females. This interaction continues for 1-3 days after the acquisition of territory by male.

Pair-formation takes place when a female lands on the back of male and subdues it (Plate 4). Just after landing both sexes start performing Back-biting. Back-biting is the display performed by both the sexes for strengthening the pair-bond. This display comprises the biting movement of the mate over the back and neck plumes (Plate 5). After pair-formation, the time score shows that Back-biting is performed at a high frequency both by males and females (Table 6 and 7; Figs. 7 and 8). Stretch Display also shows high frequency in females and serves to solicit males for copulation.

Plate 4. Female above the male during the pair-formation.

Plate 5. Male performing Back-biting by moving its half-open beak in the back plumes of female.

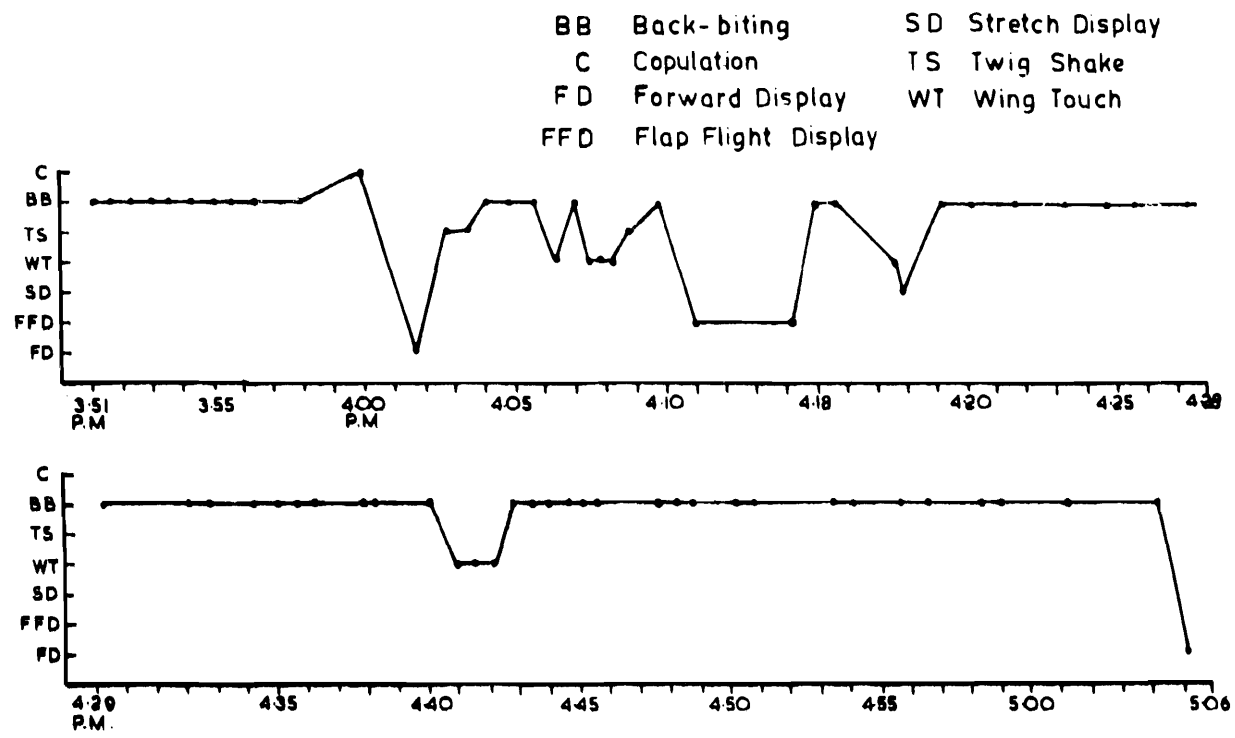


Fig. 7. Sequence of displays and copulation in paired male, just after pair - formation.

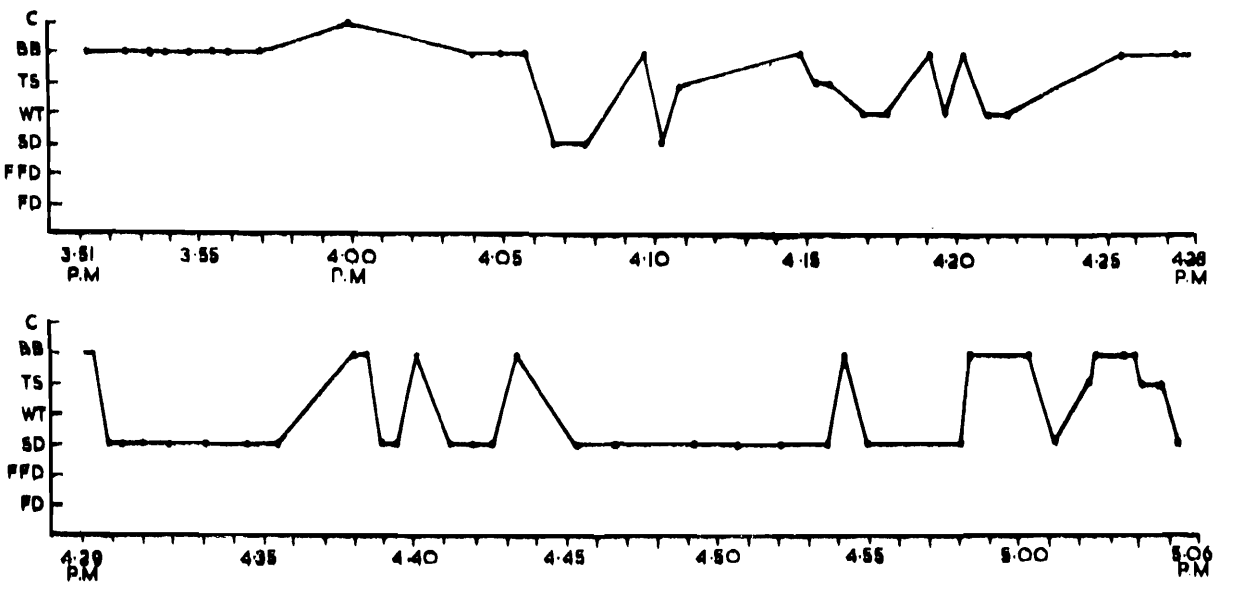


Fig. 8. Sequence of displays and copulation in paired female, just after pair - formation.

Table 6: Frequency of displays in paired male *B.i. coromandus* (data from the observations during first hour of pairing)

Sample Time (minutes)	Number of individuals observed	Name of display	Number of displays observed in sample time	Rate per minute	Rate per hour	Frequency (%)
214	8	Back-biting	409	1.02	61.6	71.3
		Twig Shake	72	0.18	10.8	12.5
		Wing Touch	66	0.16	9.9	11.5
		Stretch Display	6	0.01	0.9	1.0
		Flap Flight Display	14	0.03	2.1	2.4
		Forward Display	6	0.15	0.9	1.0
Total			573	1.55	86.2	

Table 7: Frequency of displays in paired female *B.i. coromandus* (data from the observation during first hour of pairing)

Sample Time (minutes)	Number of individuals observed	Name of display	Number of displays observed in sample time	Rate per minute	Rate per hour	Frequency (%)
398	9	Back-biting	160	0.40	24.1	39.6
		Twig Shake	50	0.12	7.5	12.3
		Wing Touch	17	0.04	2.5	4.2
		Stretch Display	177	0.44	26.6	43.8
		Flap Flight Display	—	—	—	—
		Forward Display	—	—	—	—
Total			404	1.0	60.7	

Plate 6. A copulating male above the female, flapping its wings for keeping balance.

4.34 PAIR-BOND

B.i. coromandus is monogamous in the formation of pairs as one male mates with one female at a time and the pair continues till the end of breeding season, if no casualty occurs. Replacement of mate was not observed in two cases where the females died, these nests were deserted by males after one day of female's death.

The males court each breeding season and no pair-bond is observed in non-breeding egrets. Therefore, in this case, pair is formed during each breeding season that lasts till the young ones become mature. The polygamous pair-bonds described by Lancaster (1970) in *B.i. ibis* were not observed in *B.i. coromandus*.

4.35 COPULATION

The copulation is generally followed by Stretch Display by the female during pair-formation to nest construction period and by 'Greeting Ceremony' during nest construction to hatching period. Maximum of two copulations per pair have been observed during one day.

The copulation takes place by the approach of male which steps on the female and grasps its wing, bends with clutched toes, lowers its tail and touches the cloacal aperture, the sideways movement of its tail starts alongwith the flapping of wings (Plate 6) in order to maintain the balance. The male then straightens its tail and descends from the female. The copulation is always followed by body shakes in both the sexes. The copulation in *B.i. coromandus* continues even during the incubation. The terminal copulation observed during incubation was 12 days after the laying of first egg.

Extra-pair copulation, rape according to Blaker (1969a), was observed in seven cases. Incubating male left its nest and copulated with the nearby incubating female. The female in all the cases never objected, only in three cases mild Forward Displays were given by females after the copulation.

4.4 NESTS

4.41 SITUATION AND TYPE OF HERONRIES

The heronries of *Bubulcus ibis coromandus* are located on trees in villages in the study area and are occupied year after year, if not damaged. The heronries are usually situated in the spaces between houses (Plate 7) but

seldom also occur in the domain of houses (Plate 8). In the present study, the following factors seem to influence *B.i. coromandus* to nest in human habitation.

i. In this region the temperature rises quite high resulting in frequent gales and dust-storms during summer. Because of these, quite a good number of eggs are lost. The heronries in the villages certainly face lower wind speed as compared to open-spaces (see 4.572).

ii. A permanent water resource, a village-pond, which is used by villagers for bathing their cattle, is utilized by *B.i. coromandus* for wetting their eggs during extreme hot conditions. The wetting of eggs is one of the most important activities for the hatching success and eventually for breeding success. These ponds also serve as breeding places for toads and frogs which constitute easy and bulky food for *B.i. coromandus*.

Lack (1954, 1968) opined that the ardeids nest in inaccessible areas as an anti-predatory strategy and the coloniality in ardeids results from the individuals striving to get an inaccessible area rather than an urge to nest together (passive coloniality). However, Burger (1981) stated that if inaccessible nesting areas are not limited, the occurrence of large number of birds nesting together would suggest "active coloniality" The presence of extravagant nesting areas in this study suggests the "active coloniality"in case of *B.i. coromandus*.

In this region, *B.i. coromandus* is a tree-nester. Blaker (1969a) is of the view that the flimsy, platform nests of the Cattle Egret are more suitable for reeds than trees. It is possible that the Cattle Egret shifted from reeds to trees in order to avoid heavy egg and chick predation. Also in the areas where there was absence of reeds or such breeding places, they took to trees. Shifting from reeds to trees involved ecological factors like high-speed winds which are more damaging to nests, eggs and chicks at greater heights than at lower heights. In order to avoid egg and chick-loss due to gales and dust-storms the Cattle Egret took to the nesting amidst human habitation. There are thus three evolutionary stages of nesting habit of the Cattle Egret still existing throughout the world. The first and the most primitive being reed or bush-nesting, is reported by Mackworth-Praed and Grant (1957) in East Africa, Lowe-McConnell (1967) in Guyana, and Jenni (1969) and Burger (1978) in U.S.A. The second stage, tree-nesting outside human habitation, is reported by Peterson (1965) in Missouri, Blaker (1969a), and Siegfried (1971b) in South Africa. The third and highly evolved kind, tree-nesting

Plate 7. A heronry in the space between houses.

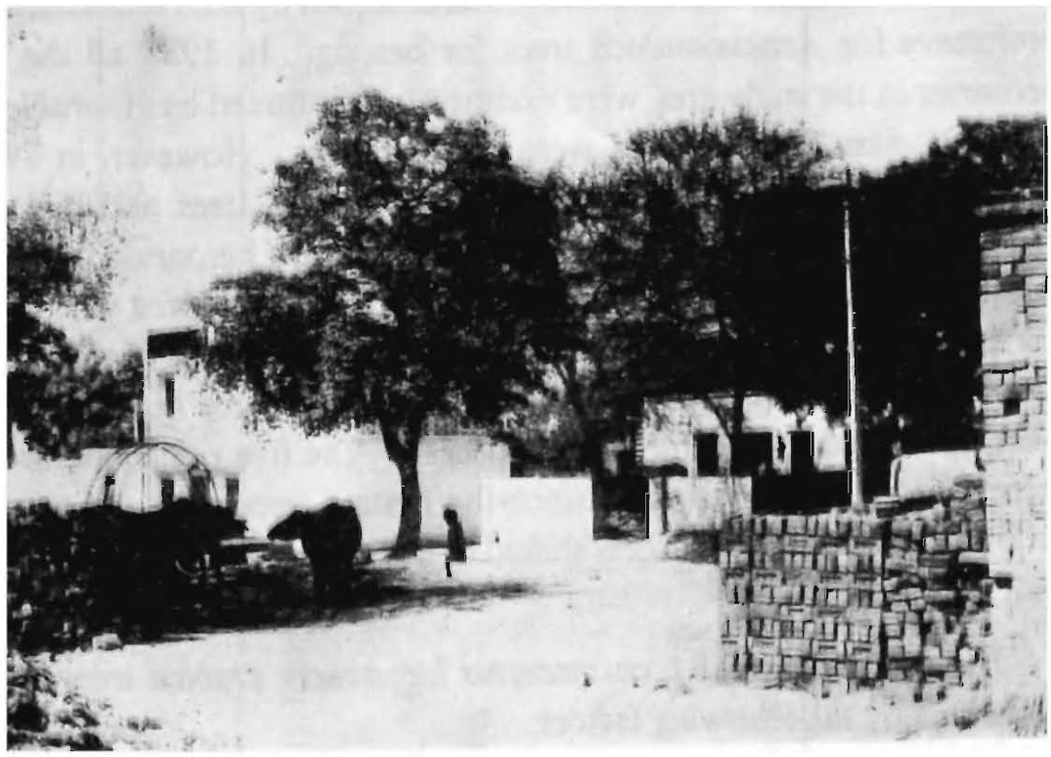


Plate 8. A heronry in the domain of a house.

inside human habitation is reported by Skead (1966) in South Africa, Demente'v and Gladkov (1969) in USSR, Ali and Ripley (1983) in India, and Baccetti (1983) in Italy.

The eleven heronries in the study area during 1983 were constituted by 1-12 nesting trees with a mean of 4.8 ± 3.6 trees and five heronries during 1984 were composed of 5-12 trees with a mean of 7.6 ± 2.7 trees. Singh and Sodhi (1985) have reported the number of nesting trees of the Cattle Egret heronries ranging from 1-17 trees with a mean of 4.0 ± 3.0 trees per heronry in 44 heronries of the tehsil Kharar of district Ropar (Punjab state). The number of nests in the heronries during 1983 ranged from 15-134 with a mean of 62.2 ± 36.2 nests and during 1984 the number of nests in heronries ranged from 63-176 with a mean of 121 ± 41.7 nests. Singh and Sodhi (1985) have reported the number of nests in Cattle Egret heronries ranging from 5-220 with a mean of 54.5 ± 46.2 nests in 44 heronries. The number of nests harboured by each tree of heronries ranged from 1-51 with a mean of 13.9 ± 13.1 nests during 1983. During 1984 the range was 2-65 nests with a mean of 15.8 ± 14.5 nests. Singh and Sodhi (1985) have reported the number of nests harboured by each tree in 44 heronries with a range 1-62 and mean of 12.0 ± 10.1 nests.

One of the most characteristic features shown by *B.i. coromandus* is the preference for *Acacia arabica* trees for nesting. In 1983 all the eleven heronries in the study area were exclusively constituted by *A. arabica* trees i.e. 100% nests in study area were on these trees. However, in 1984 six heronries were deserted due to felling of nesting trees and disturbance created by human beings. Out of the five functional heronries during 1984, in the study area, two were purely constituted by *A. arabica* whereas three heronries were extended to other trees besides *Acacia* trees (Table 8). Even then the latter held 95.5% of total nests in the study area in 1984, the other trees harboured less than 5% of total nests. The five remaining heronries were flooded with egrets and since the nesting trees were not enough to accommodate them, the excess shifted to trees other than of their preference near heronries.

The preference of *B.i. coromondus* for *Acacia arabica* trees could be accounted by the following factors:

i. *Acacia arabica* trees have very strong wood; even the upper-most very thin branches can support the nests.

Table 8: Tree-preference during 1984

Name of Heronry	Total number of trees in heronry	Type of trees	Number of trees	Number of nests on trees	Percentage of nests on trees
Bharaunjian	8	*Acacia arabica*	7	173	98.2
		Zizyphus jujuba	1	3	1.7
Rani Majra	5	*Acacia arabica*	5	63	100
Palheri	12	*Acacia arabica*	11	118	98
		Melia azadirachta	1	1	1.6
Maloya	7	*Acacia arabica*	4	117	83.5
		Dalbergia sissoo	2	15	10.7
		Prosopis spicigera	1	8	5.7
Manana	6	*Acacia arabica*	6	106	100

ii. Thin tree-trunks and shoots alongwith compound leaves do not offer much resistance to winds. The chances of uprooting of the tree and breaking of branches with high-speed winds are very remote.

iii. *A. arabica* is a thorny tree which makes nests of *B.i. coromondus* almost inaccessible.

iv. These trees are easily available, being one of the most common trees in the area.

Burger (1979) has given a classification of heronries based on the structure of the vegetation. In the present study it is observed that classification of heronries based on one or two sets of characters, gives incomplete information. A system of classification of heronries is being developed on the bases of observation and literature cited which could be useful on world-wide basis. On the basis of variations in heronries the following five sets of characters are taken:

(i) On the basis of location, heronries can be divided into two types. When associated with human habitation these can be called "Associated heronries" represented by "A" These heronries are more safe from gales, dust-storms and predators (see 4.572). When not associated with human habitation and located in marshes, fields and other areas, these can be called "Free heronries" represented by "F" The free heronries are more exposed to gales, dust-storms and also to predators.

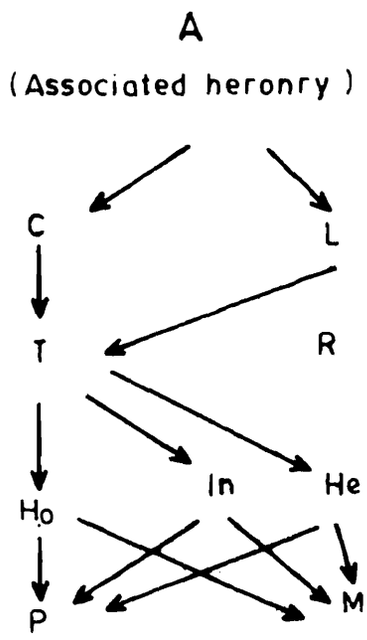
(ii) On the basis of physiognomy (appearance of heronries) the heronries can be divided into two main types. When the plants comprising the heronries are close enough forming a single, compact section, the plants not being more than twenty meters apart from each other, the heronry can be called as "Compact heronry" A compact heronry may have one to many trees and is represented by "C" A compact heronry has synchronous anti-predatory responses. If a predator or human being enters the heronry, all the dwelling herons/egrets respond at the same time. When the plants form two to many sections, each section comprising one to many plants and is located at more than twenty meters distance from other sections, the heronry can be called as "Loose heronry" represented by "L" A loose heronry has isolated anti-predatory responses; each section responds independently.

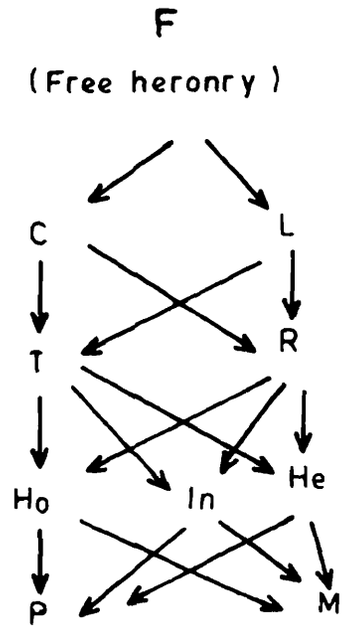
(iii) On the basis of general plant types, heronries can be divided into two types. If the heronry comprises reeds or bushes, it can be called as "Reed heronry" represented by "R" The reed or bush heronries are highly

subjected to predation by birds, reptiles, and mammals (Nicholson, 1929; Noskiewicz, 1964; Dusi and Dusi, 1968; Tomlinson, 1974). If heronry is constituted by trees, it can be called as "Tree heronry", represented by "T" The tree heronries are safer from predation (Blaker, 1969a; Siegfried, 1971b).

(iv) Burger (1979) has classified heronries on the basis of structure of the vegetation into two types: "Homogeneous heronries" constituted by either all one species of vegetation evenly distributed (not clumped), or more than one species of vegetation intermixed such that each area of heronry looks like every other area. "Heterogeneous heronries" are composed of sub-areas that differ with respect to species of vegetation, height of vegetation and number and percentage of open or edge areas. In the present instance, terms Homogeneous and Heterogeneous are based solely on plant types, "Homogeneous heronries" being those which are constituted by one type of plants and the "Heterogeneous heronries" are those which are constituted by more than one type of plants. In the present study it was noted that there was a gradual shift from Homogeneous to Heterogeneous heronries. In two of the heronries 98.2% and 98.3% of the nests were harboured by one type of plants whilst only 1.8% and 1.7% nests were on minority plant types. Here it will be misleading to call thes heronries as Heterogeneous. Therefore, if the heronries have less than 5% of nests harboured by minority plants, the heronries can be called as "Intermediate heronries" Hence, the Homogeneous heronries constituted by one type of plants can be represented by "Ho", the Heterogeneous heronries constituted by more than one type of plants when the minority plants have 5% or more than 5% of nests can be represented by "He" The Intermediate heronry can be represented by "In"

(v) On the basis of resident heron/egret species the heronries can be divided into two types. If more than one species of herons/ egrets breed together the heronries can be called "Mixed heronries" represented by "M" Burger (1981) is of the view that social facilitation is presumably less in the mixed heronries as compared to the pure heronries. Moreover, the mixed heronries are reported to be horizontally stratified (McCrimmon, 1978; Meanley, 1955) or vertically stratified (Jenni, 1969; Burger, 1978). If only one species breeds in a heronry, the heronry can be called as "Pure heronry", represented by "P" In the study area it was observed that *B.i. coromandus* and *Ardeola grayii* sometimes nest in the same village but never on the same trees. Therefore, the heronries of *B.i. coromandus* and *A. grayii* are considered as Pure heronries.





1	ACT H_o P	1	FCT H_o P	13	FLT H_o P
2	ACT H_o M	2	FCT H_o M	14	FLT H_o M
3	ACT In P	3	FCT In P	15	FLT In P
4	ACT In M	4	FCT In M	16	FLT In M
5	ACT He P	5	FCT He P	17	FLT He P
6	ACT He M	6	FCT He M	18	FLT He M
7	ALT H_o P	7	FCR H_o P	19	FLR H_o P
8	ALT H_o M	8	FCR H_o M	20	FLR H_o M
9	ALT In P	9	FCR In P	21	FLR In P
10	ALT In M	10	FCR In M	22	FLR In M
11	ALT He P	11	FCR He P	23	FLR He P
12	ALT He M	12	FCR He M	24	FLR He M

Fig. 9. Possible combinations in case of Associated and Free heronries.

Table 9: Type of heronries during the years of study in the study area

Name of heronry	Type of heronry (1983)	Type of heronry (1984)
Ferozpur Bangal	ALTHoP	Deserted
Khuda Lahora	ACTHoP	Deserted
Dhanas	ACTHoP	Deserted
Dadu Majra	ALTHoP	Deserted
Maloya	ALTHoP	ALTHoP
Bharaunjian	ACTHoP	ACTInP
Rani Majra	ALTHoP	ALTHoP
Palheri	ALTHoP	ALTInP
Manana	ALTHoP	ALTHoP
Togan	ACTHoP	Deserted
Wasepur	ACTHoP	Deserted

A combination of the above five sets of characters can be used to give a complete information about heronries. As the reed nesting is not reported in human habitation, therefore, it can be excluded from the combinations of Associated heronries (Fig. 9). The heronries in general can be divided into two basic types: Associated and Free heronries. Twelve combinations are possible in Associated heronries and 24 in Free heronries. If it is stated that a particular heronry is the type of ACTHoP, it depicts Associated, Compact, Tree, Homogeneous and Pure heronry. The heronries in the study area during 1983 and 1984 are classified in Table 9 following the above system.

4.42 SITE AND HEIGHT OF NESTS

The nest site is always selected by males in case of *B.i. coromandus.* The early breeders usually occupy old nests and add new material to them. The material from unoccupied nests is used. The late breeders select new sites and form new nests. The nest site is selected in the forks of upwardly directed shoots. Some of the nests are also made on the branches directed sideways.

B.i. coromandus nests at a considerable height,5.85-15.65 meters with a mean of 9.63 $\pm$ 2.71 meters (from the measurements of nest heights in three heronries) in the study area. Burger (1978) has given nest height of *B.i. ibis*

as 0.70 ± 0.315 meters in a reed heronry in New Jersey. Jenni (1969) has given nest height of *B.i. ibis* as 2.38 ± 0.05 in a mangrove heronry in Florida. The above mentioned heights are at reeds and mangroves which are considerably lower as compared to the heights observed in the present study. The main reason for this seems to be that *B.i. coromandus* keeps a moderate distance from human beings when the heronries are of Associated type. In all the heronries observed in the study area the lowest nest height was 5.85 meters, which is more than three times average height of human beings. The lowest height which *B.i. coromandus* maintains in human habitation can be termed as 'Human distance'

The height of nests both in Loose and Compact heronries was measured during 1983 and 1984 (Figs. 10 and 11). It was observed that all the nests occupied the upper half of trees. During 1983 at Ferozpur Bangal heronry (a Loose heronry) it was observed that section 1 where the maximum height of trees was 12.42 meters, was the first one to be occupied by *B.i. coromandus* on 2 May, while sections 2 and 3 which had the respective height of 11.09 and 8.70 meters were occupied on 8 May and 17 May respectively. The occupation of sections with the onset of breeding season thus depends upon the height of section in Loose heronries.

In 1983 at Rani Majra heronry, another Loose heronry, it was observed that previously existing sections 2, 3 and 4 were occupied on the basis of height-preference on 8 May, 17 May and 26 May respectively. While section 1, which was newly added to the heronry during that year was acquired on 2 June. In the next year 1984, section 1 which was the highest of all the sections was the first to be acquired on 6 May, 1984. Here it can be stated that temporal occupation of different sections in a heronry on the basis of height preference is restricted to the previously existing sections. The newly added sections may have higher height than the previously existing sections.

The same kind of height-preference was observed in the Compact heronry of Bharaunjian. There were four nesting trees during 1983 at Bharaunjian heronry. During 1984, with the onset of breeding season the trees 1 and 2 were occupied on 4 May while the trees 3 and 4 were occupied on 8 May and 11 May respectively. During 1984, four new trees were added in Bharaunjian heronry which nad variable heights and were acquired after 11 May.

The reason for this height-preference seems to be that the higher nests in human habitation are safer and chances of disturbance are much less.

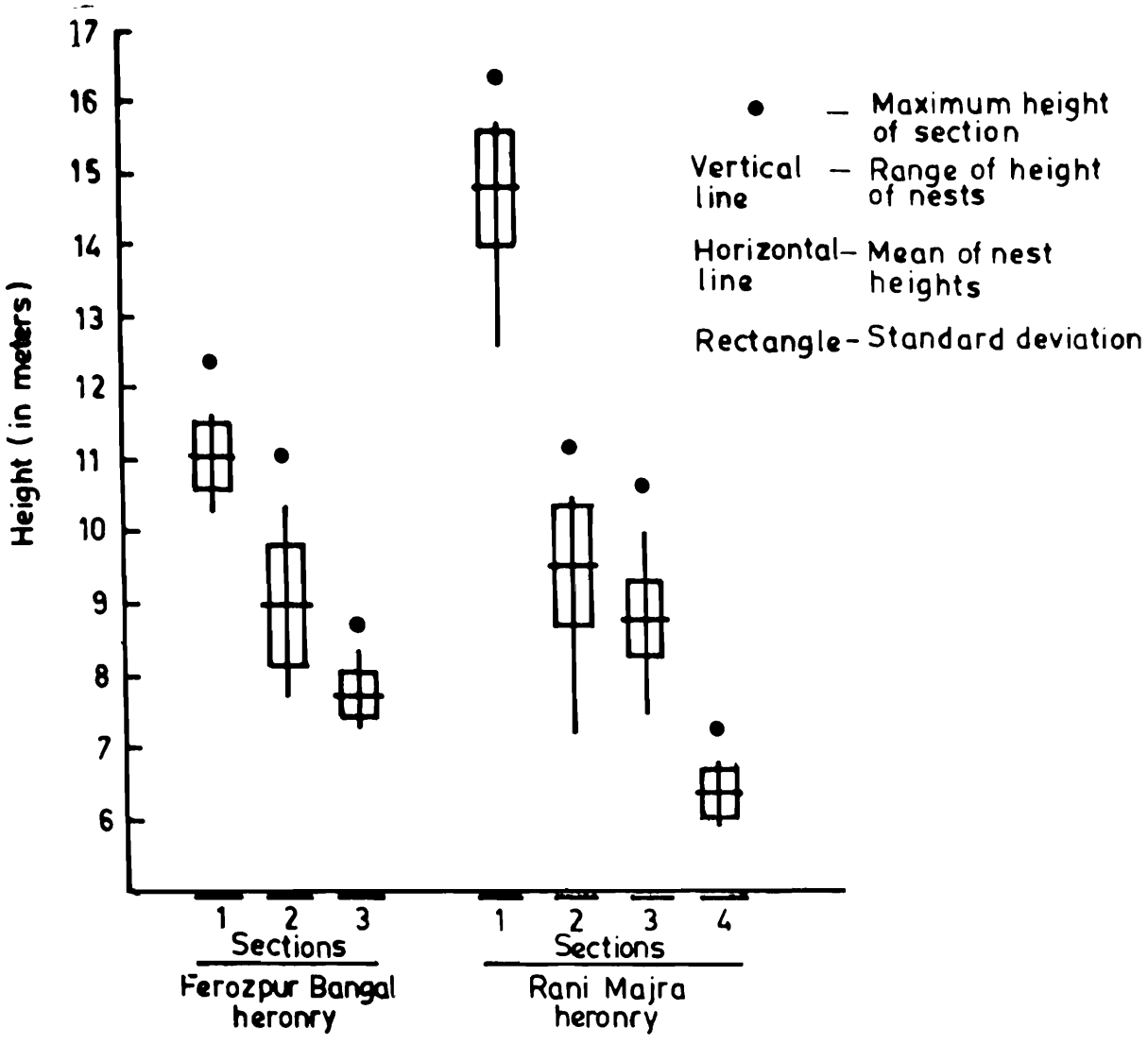


Fig. 10. Height of nests in different sections of two Loose heronries.

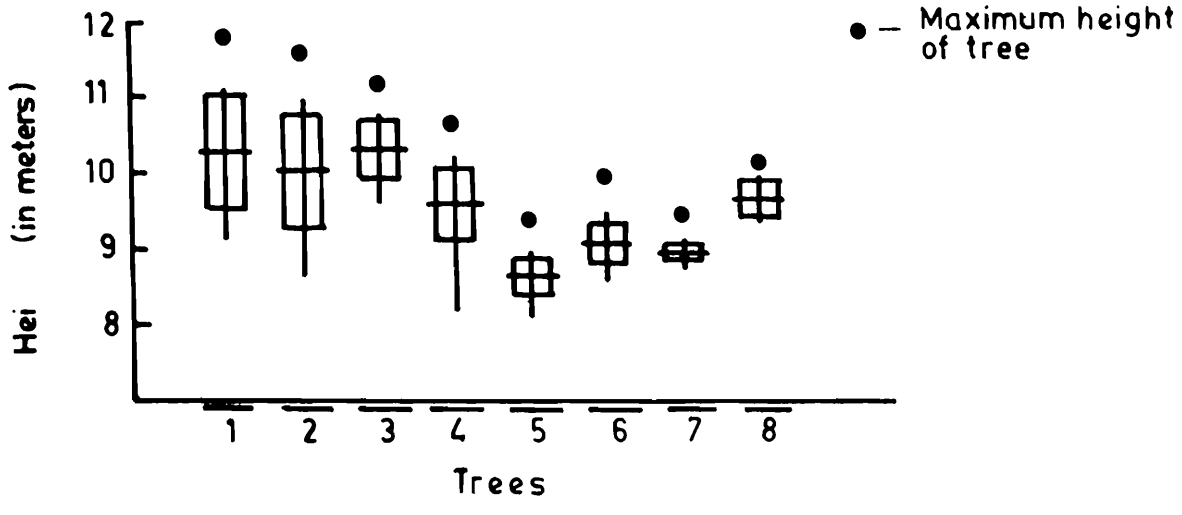


Fig. 11. Height of nests in different trees of Compact heronry of Bharaunjian.

4.43 BEHAVIOUR DURING NEST-BUILDING

4.431 *Share of sexes*

A marked division of labour is shown during nest-building in case of *B.i. coromandus*. The male brings the twigs, one by one for nest construction (Plate 9) while the female does the adjustment of twigs. This type of division of labour is also reported in *Florida caerulea* (Meanley, 1955), and *Bubulcus ibis ibis* (Blaker, 1969a; Siegfried, 1971b). Siegfried (1971b) is of the view that the division of labour in *B.i. ibis* is an adaptation for compensation of the future investment of female on egg-laying.

As the heronries are occupied year after year, on the commencement of breeding season the old nests in good condition are occupied whereas the nesting material from the remaining deformed nests is utilized in the construction of new nests or added to the old nests. With the start of breeding season the heronries have enough nesting material in the form of deformed nests, fallen twigs on the ground and also the dried shoots of the nesting trees. At Rani Majra in one section of heronry during 1984, 92.2% of the total nesting material added on the second day of nest construction was collected from the heronry itself i.e. from the old nests, twigs of the nesting trees and from the ground below the heronry. The percentage of nesting material used from the heronry went on decreasing with time and on the 40th day it was only 8.7% of the total material brought in (Fig. 12). On the other hand, material collected from outside increased from 7.8% on the 2nd day to 91.3% on the 40th day (Fig. 12). This indicates that material available in the near vicinity of the nests is consumed first; it requires minimum investment of energy. And then, the nesting material from distant places is exploited.

It was observed that near every heronry there was one tree from which the maximum twigs were broken. During peak nest-building activities 15 males of *B.i. coromandus* were observed breaking twigs from one such tree at Bharaunjian colony. Such trees can be called as "Mother twig trees" as they supply most of nesting material from outside.

The stealing of twigs from nearby nests which is reported to be a very common phenomenon in *B.i. ibis* (Blaker, 1969a; Siegfried, 1971b), was also observed in *B.i. coromandus*. This twig stealing activity, however, is not very frequent. The colonies in the present area being very small in size as compared to those of South Africa, competition for twigs is almost negligible. However, if a nest is deserted, the material is readily utilized by other egrets to construct their nests (Plate 10).

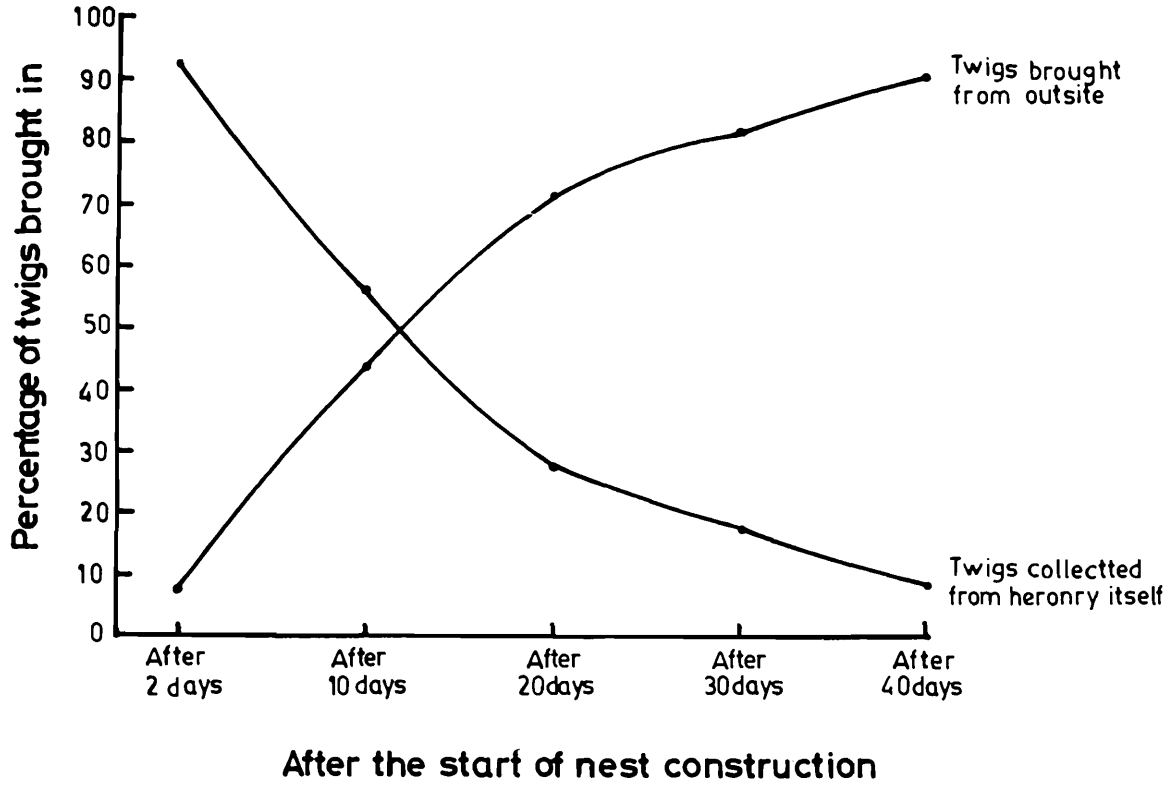


Fig. 12. Usage of twigs in one section of Rani Majra heronry.

4.432 *Nest construction techniques*

Push and pull. This technique was first reported by Blaker (1969a) in case of *B.i. ibis.* In case of *B.i. coromandus,* "Push and Pull" comprises the alternate pushing and pulling of twigs in a perched position, so as to break them. During intensive push and pull, the wings are flapped for maintaining the balance. Push and Pull is always performed by males.

Aim and arrange. This technique is performed by females after taking twigs from males. The female with twig in its beak, stretches its neck in vertical position and makes 2-4 downward and upward movements of head as if aiming at nest. Rotation of body is also accompanied with aiming so as to observe every part of nest. The twig is then arranged in the nest. This technique is being reported for the first time.

Tremble-shove. This technique was reported by Lorenz (1955) as nest-building technique in ardeids. In *B.i. coromandus* this technique is performed by both the sexes. The egret while sitting in the nest, holds a twig of nest and shoves it inside after trembling movements of head. The main function of this technique is to tuck the outer loose ends of twigs present on

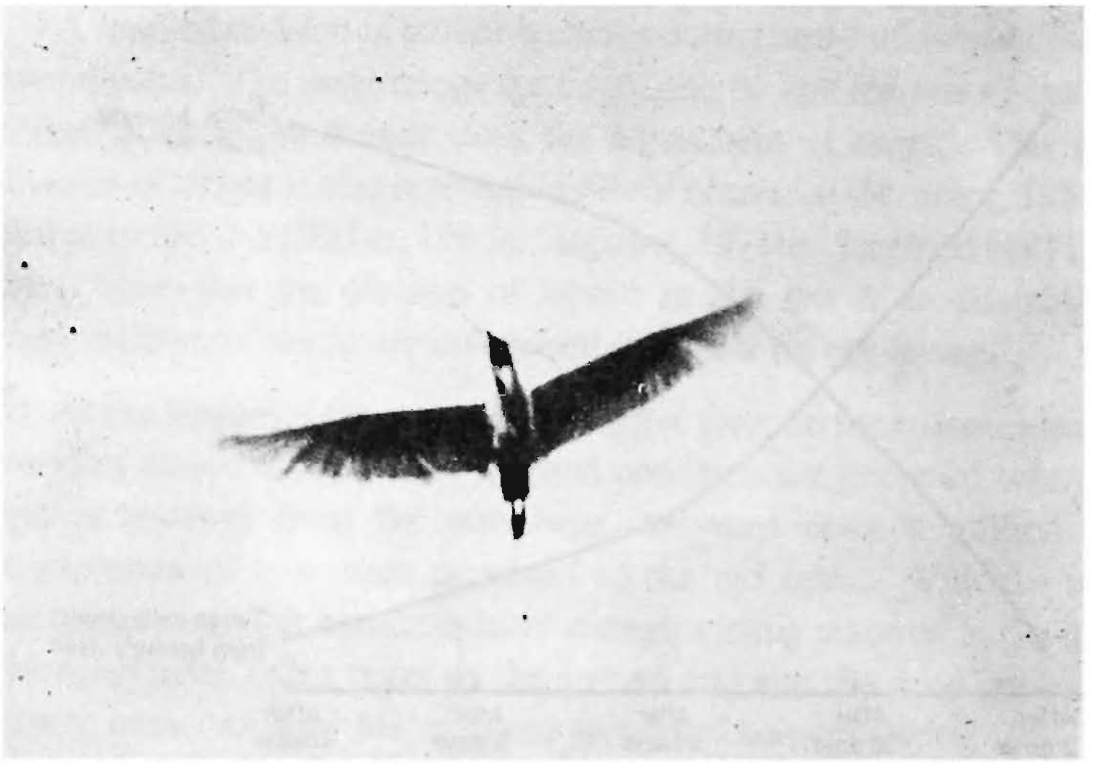


Plate 9. Male bringing twig for nest construction.

Plate 10. A male collecting material from a deserted nest in Bharaunjian heronry while female waits (above right).

the upper surface of nest into the interior of nest so as to form a compact nest.

4.433 *Greeting Ceremony*

A Greeting Ceremony is performed by the owner of nest to the incoming mate. The Greeting Ceremony comprises the main component of Stretch Display (Fig. 6, e-g). The incoming egret starts vocalizing (Rick-rack calls) when it is a few meters away from the nest. The owner of nest performs 2-3 bows. The ceremony continues to occur till the brooding. The main function of Greeting Ceremony is to strengthen the pair-bond.

4.434 *Time taken for nest construction*

Nest-building is a continuous process which extends up to the first hatching. The material is continuously added during egg-laying and incubation. The sight of first hatching seems to be the main inhibiting stimulus for twig-gathering motivation in males. The other nest construction techniques also cease to occur after first hatching.

The number of twigs added to the old-occupied nest was less, 8.2 ± 3.8 twigs per nest, per day (mean of 9 nests) as compared to the 32.3 ± 12.2 twigs per nest, per day (mean of 6 nests) in new nest constructions before egg-laying. After egg-laying there was not much difference in the number of twigs added in old and new nests; 13.8 ± 5.3 twigs per nest, per day (mean of 11 nests) in old nest, 17.1 ± 8.5 twigs per nest, per day (mean 9 nests) in new nests.

The time taken from the start of nest-building to the day when first egg was laid, is given in Tables 10 and 11. It was observed that this time was less in the egrets which had occupied the old nests as compared to those which made fresh nests.

4.44 SHAPE AND SIZE OF NESTS

The nests in case of *B.i. coromandus* are loose to compact network of twigs. These are narrow at the base and diverge to the top. Twigs can be seen coming out from the base and the middle. Heavy, long, and thick twigs are used to form the base and middle while upper-shallow cup comprises thin, small, and light twigs. In every nest 2-4 branches of nesting tree comprising the fork are involved so that the nests may not dislodge with high-speed winds. Sometimes, the branches of nearby shoots are pulled and are involved in the nest. This again contributes to the stability of nest in the fork.

Table 10: Frequency distribution of the time taken from the start of nest-building to the laying of first egg in cases where old nests were occupied

Number of old occupied nests	Number of cases taking 3 days	4 days	5 days	6 days	7 days	Mean (days)	Standard deviation (days)
36	14	11	6	4	1	4.8	1.11

Table 11: Frequency distribution of the time taken from the start of nest-building to the laying of first egg in cases where new nests were constructed.

Number of cases observed	Number of cases taking 5 days	6 days	7 days	8 days	9 days	Mean (days)	Standard deviation (days)
53	4	26	17	6	0	6.47	0.79

The maximum diameter of nests noted during the egg-laying in 17 nests at Bharaunjian colony was 25.7 ± 2.8 cm. with a range of 22.8 - 29.3 cm., the depth of cup was 2-6 cm. with mean of 3.2 ± 2.3 cm. The maximum diameter increased to a mean of 43.5 ± 10.8 cm. with a range of 30.2 -51.8 cm. during the fledgling stage of nestlings; the depth of cup ranged from 6.3 to 13.1 cm. with a mean of 9.2 ± 3.1 cm.

4.45 NEST MATERIAL

Twigs of different trees and plants are used for building the nest. The nests contained 142 -289 twigs with a mean of 194.4 ± 44.2 twigs per nest (data from 16 nests of Maloya heronry). The twig number was 158 -253 with a mean of 179.51 ± 39.1 twigs per nest (mean of 12 nests from Bharaunjian heronry).

4.451 *Type of twigs*

The type of twigs found at Bharaunjian and Maloya heronry during 1984 is shown in Figs. 13, 14 and 15. The study revealed that the *Acacia arabica* twigs dominated percentage-wise at Bharaunjian heronry (Intermediate heronry) when a mean of eight nests removed from *Acacia* Trees was taken (Fig. 13). In Maloya heronry (Heterogeneous heronry) the percentage of *Acacia arabica* twigs was higher in the nests removed from *Acacia* trees (Fig. 14) while the percentage of *Dalbergia sissoo* Twigs was higher in the nests removed from *Dalbergia* trees (Fig. 15). The usage of same type of twigs as that of nesting trees show that the nesting material from the same tree or same type of trees is used for constructing the nest. This shows the tendency of the species towards saving of energy as well as camouflaging of nests. In colonial species camouflaging of nests play a major role in the potection of species from predators (Patterson, 1965; Tinbergen, Impekoven and Frank, 1967).

4.452 *Weight of twigs*

Weight of twigs in case of nine nests removed from Maloya heronry was taken. The lightest twig weighed 0.121 gm. and the heaviest 10.208 gm. with a mean of 1.610 ± 1.40 gm. Frequency distribution for the weight of twigs is given in Fig. 16. The heavier twigs formed the base and middle part while the lighter ones formed the upper saucer of nest. The side lining of nest contained moderately heavy twigs.

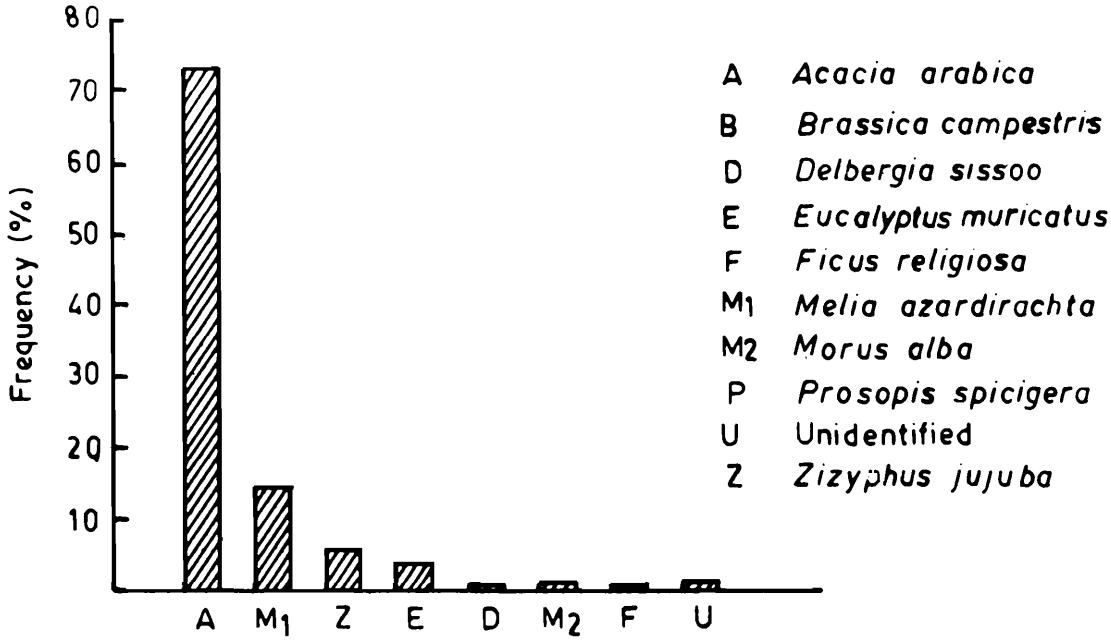


Fig. 13. Type of twigs in eight nests taken from *Acacia arabica* trees of Bharaunjian heronry, 1984.

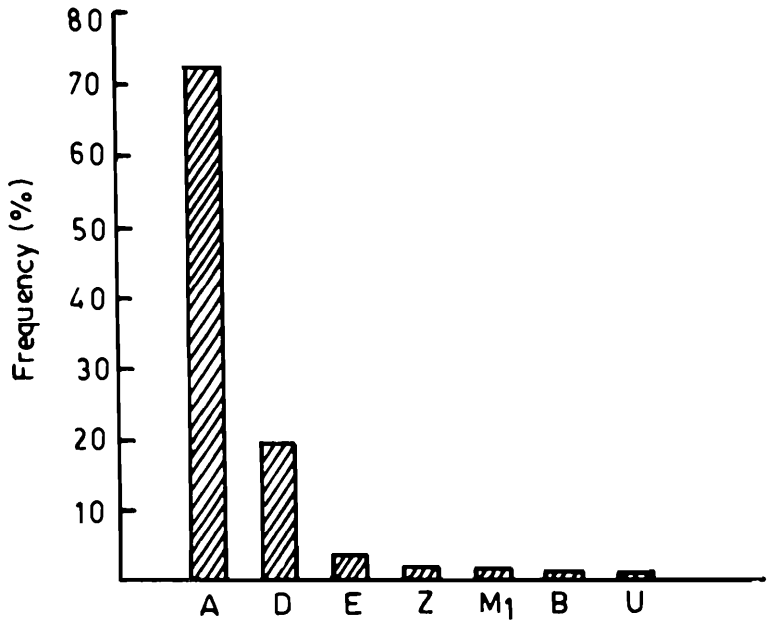


Fig. 14. Type of twigs in six nests taken from *Acacia arabica* trees of Maloya heronry, 1984.

Fig. 15. Type of twigs in six nests taken from *Dalbergia sissoo* trees of Maloya heronry, 1984.

4.453 *Length of twigs*

Length of twigs in case of nine nests from Maloya heronry was measured. The smallest twig was 8.2 cm. while the longest 63.2 cm. with a mean of 24.7 ± 10.66 cm. Frequency distribution for the length of twigs is given in Fig. 17. The longer twigs formed the base and middle part while the upper nest was lined with smaller twigs. The sides of the cup were lined with moderately long twigs.

4.545 *Thickness of twigs*

Frequency distribution for the thickness of twigs taken in case of nine nests from Maloya heronry is given in Fig. 18. Thickest twig was 8 mm. and the narrowest 1.6 mm. with a mean of 3.6 ± 0.16 mm. Thicker twigs formed base and middle of the nest while narrow twigs formed the upper shallow saucer.

4.455 *Texture of twigs*

Twigs of *Acacia arabica* are texturally rough and budded; spined or unspined. Twigs of *Dalbergia sissoo* are sleek and without spines. Twigs of *Melia azadirachta* are rough but without spines. Twigs of *Zizyphus jujuba* are always spined.

Nests on *Acacia arabica* and *Dalbergia sissoo* trees were removed from the Heterogeneous hernory of Maloya. It was observed that the percentage of spined twigs from nests removed from *Acacia arabica* trees was lower as compared to those of the nests removed from *Dalbergia sissoo* trees. As the function of spined twigs is to entangle the other twigs so as to give a compact mass, the percentage of spined twigs is higher in the cases where the higher percentage of sleek twigs is used (Table 12).

Table 12: Percentage of spined twigs in Maloya heronry, 1984

Name of heronry	Nests removed from	No. of nests studied	Total No. of twigs in nests	Total No. of spined twigs	% of spined twigs
Maloya	*Acacia arabica*	6	1290	223	17.2
	Dalbergia sissoo	6	1194	312	26.1

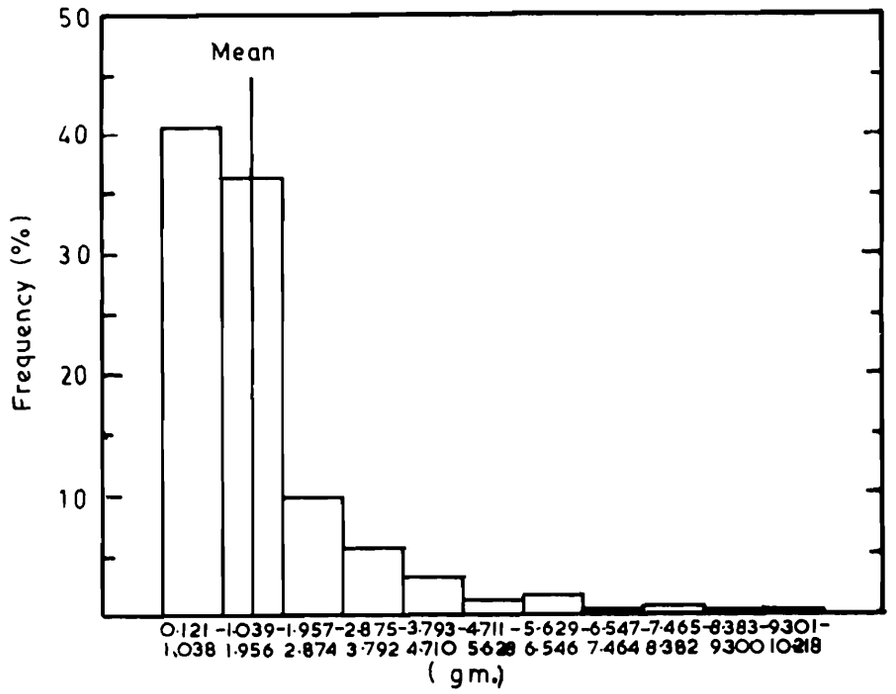


Fig. 16. Frequency distribution of the weight of twigs.

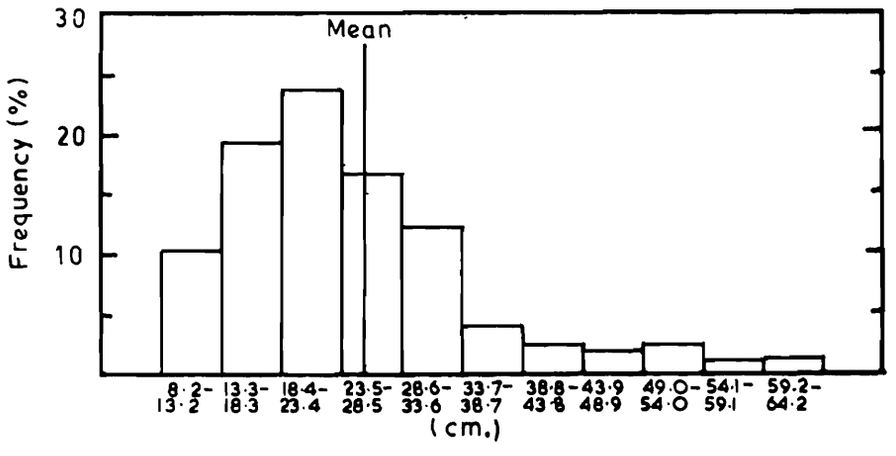


Fig. 17. Frequency distribution of the length of twigs.

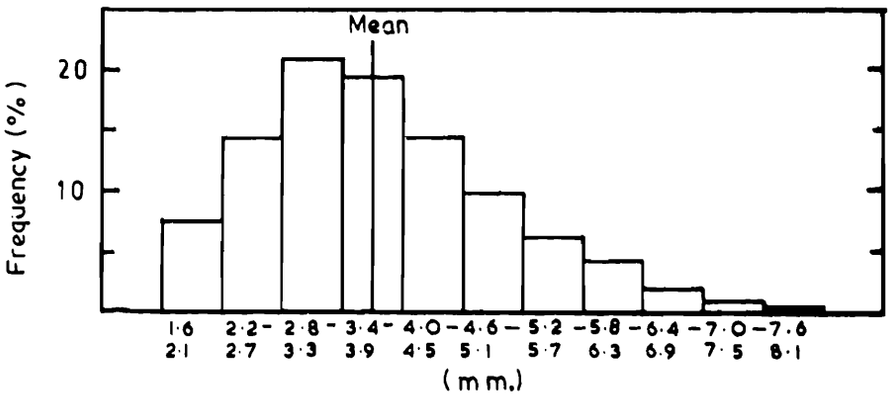


Fig. 18. Frequency distribution of the thickness of twigs.

4.46 NESTING ASSOCIATIONS

In the study area *B.i. coromandus* had Pure heronries which were the result of no association with other birds. The yellow wasp (*Polistis hebraeus*) was very commonly seen nesting in association with *B.i. coromandus* nests. Density of nests of *B.i. coromandus* was noted to be higher around the nests of *Polistis hebraeus*. This association was beneficial for *B.i. coromandus* as it stopped the human intrusion *B.i.coromandus* was never observed disturbing yellow-wasp nests or devouring them. In the light of present observations this relationship can be called as commensalism, as *B.i. coromandus* is benefited and *Polistis hebraeus* is neither harmed nor benefited. Such protective nesting associations in other birds are also reported by Baker (1931), Alexander (1931), Moreau (1936) and Sparks (1979).

4.5 EGGS

4.51 SIZE OF EGGS

In a sample of 240 fresh eggs observed in 63 clutches, the minimum egg length was 40.00 mm. and minimum breadth was 31.2 mm., the maximum egg length was 49.7 mm. and maximum breadth of eggs was 38.7 mm. Mean length was 44.3 $\pm$ 3.9 mm. and mean breadth was 34.1 $\pm$ 2.8 mm. Frequency distribution for the length and breadth of eggs is given in Tables 13 and 14. Hancock and Kushlan (1984) have recorded egg length of the Cattle Egret ranging from 40.4 - 45.7 mm. and breadth from 31.7 - 36.5 mm.

4.52 SHAPE OF EGGS

In a sample of 240 fresh eggs, 196 (81.6%) were oval, 33 (13.7%) were biconical and 11 (4.5%) were elliptical (Plate 11). Above three shapes were frequent even in the same clutches.

Shape-index of eggs explained by Romanoff and Romanoff (1949) was determined in the above sample of eggs.

$$\text{Shape-index} = \frac{\text{Breadth} \times 100}{\text{Length}}$$

Longer and thinner eggs showed the low shape-index while shorter and thicker eggs showed high shape-index. The highest shape-index was 85.99 which was the result of 44.6 mm. and 38.4 mm. length and breadth

Table 13: Frequency distribution of the length of eggs in a sample of 240 fresh eggs

Sr. No.	Class intervals (mm.)	Frequency	Frequency (%)	Mean (mm.)	Standard deviation (mm.)
1	40.0-41.2	12	5.0		
2	41.3-42.5	32	13.3		
3	42.6-43.8	48	20.0		
4	43.9-45.1	76	31.6	44.3	3.9
5	45.2-46.4	48	20.0		
6	46.5-47.7	12	5.0		
7	47.8-49.0	4	1.6		
8	49.1-50.3	8	3.3		

Table 14: Frequency distribution of the breadth of eggs in a sample of 240 fresh eggs

Sr. No.	Class intervals (mm.)	Frequency	Frequency (%)	Mean (mm.)	Standard deviation (mm.)
1	31.2-32.1	19	7.9		
2	32.2-33.1	39	16.2		
3	33.2-34.1	72	30.0		
4	34.2-35.1	56	23.3	34.1	2.8
5	35.2-36.1	28	11.6		
6	36.2-37.1	8	3.3		
7	37.2-38.1	6	2.5		
8	38.2-39.1	12	5.0		

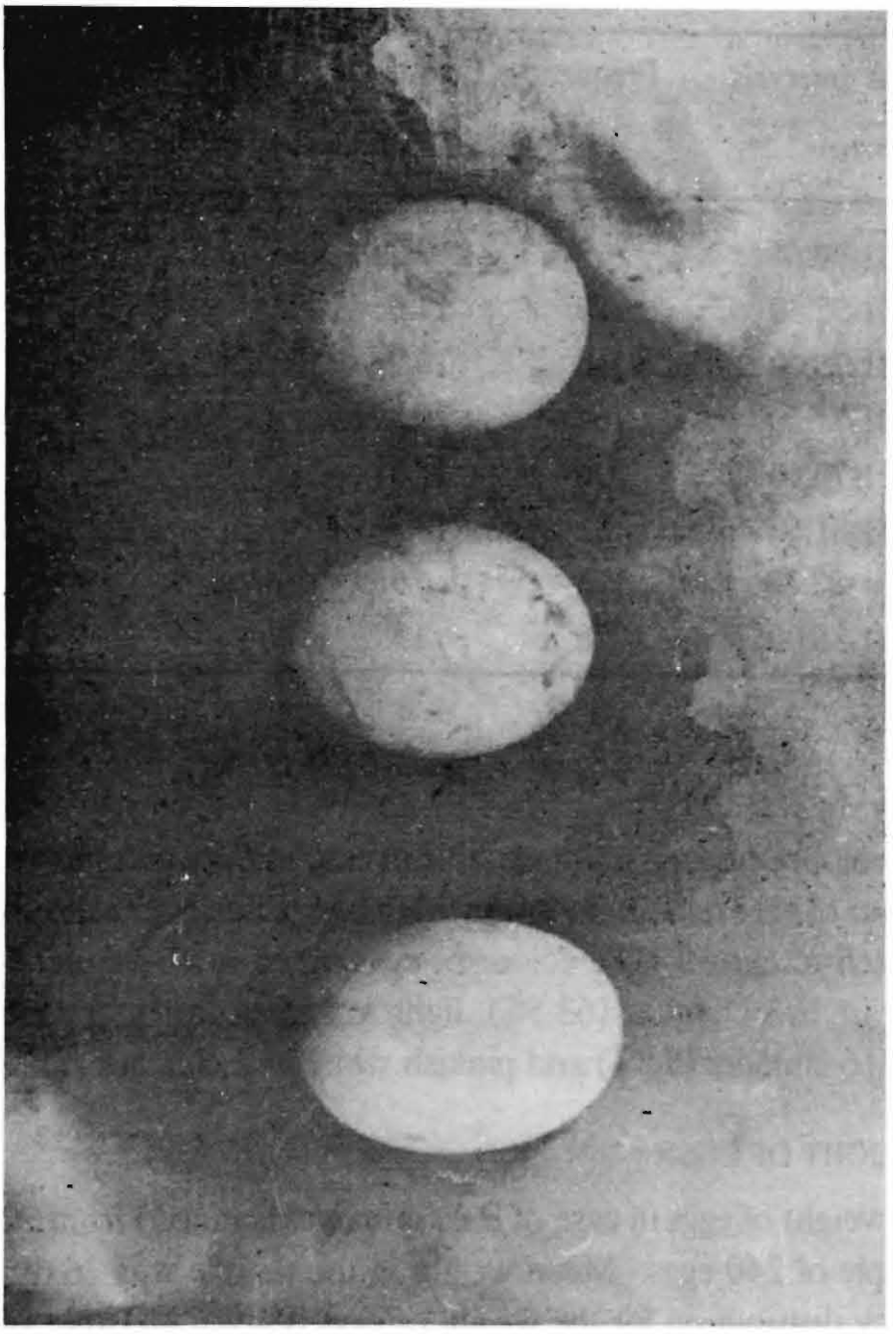


Plate 11. Different shapes in the eggs; oval on left, biconical in the centre and elliptical on right.

respectively. The lowest-shape index was 68.41 which was the result of 49.7 mm. and 34.0 mm. respective length and breadth. Frequency distribution for the shape-index is given in Table 15.

Table 15: Frequency distribution for the shape-index of eggs in a sample of 240 fresh eggs

Sr. No.	Class intervals	Frequency	Frequency (%)	Mean	Standard deviation
1	68.41-70.60	8	3.3		
2	70.61-72.80	28	11.6		
3	72.81-75.00	48	20.0		
4	75.01-77.20	64	26.6	76.57	13.70
5	77.21-79.40	36	15.0		
6	79.41-81.60	32	13.3		
7	81.61-83.80	16	6.6		
8	83.81-86.00	8	3.3		

4.53 COLOUR OF EGGS

The colour of eggs is quite variable in case of *Bubulcus ibis coromandus*. The colour of eggs remain uniform within one clutch but varies considerably from clutch to clutch. The colour of eggs noted in 162 clutches was light sky-blue in 103 clutches (63.5%), light sea-green in 41 clutches (25.3%), white in 16 clutches (9.8%) and pinkish white in 2 clutches (1.2%).

4.54 WEIGHT OF EGGS

The weight of eggs in case of *B.i. coromandus* ranged from 22 to 32 gm. in a sample of 240 eggs. Mean weight in the sample was 26.6 ± 5.86 gm. Frequency distribution for the weight of eggs is given in Table 16.

4.55 LAYING SEQUENCE

The eggs were not laid after definite intervals. First egg was laid 4.08 ± 1.11 days after the start of addition of new material to the old occupied nests and 6.47 ± 0.79 days after the start of new nest construction (Tables 10 and 11). Second egg was laid 1-5 days after the laying of first egg, with a mean

of 1.97 ± 0.59 days (Table 17). Third egg was laid 1-6 days after the laying of second egg with a mean of 2.17 ± 0.79 days. Fourth and fifth eggs were laid 1-10 days and 1-6 days with a mean of 2.29 ± 1.13 days and 2.57 ± 1.09 days after the laying of third and fourth egg respectively.

It can thus be stated that the last eggs 4 and 5 in large clutches are laid after longer intervals as compared to the eggs 2 and 3.

Table 16: Frequency distribution for the weight of eggs in a sample of 240 fresh eggs

Sr. No.	Class intervals (mm.)	Frequency	Frequency (%)	Mean (mm.)	Standard deviation (mm.)
1	22.0-23.2	28	11.6		
2	23.3-24.5	16	6.6		
3	24.6-25.8	36	15.0		
4	25.9-27.1	76	31.6	26.6	5.86
5	27.2-28.4	32	13.3		
6	28.5-29.7	20	8.3		
7	29.8-31.0	24	10.0		
8	31.1-32.3	8	3.3		

Table 17: Frequency distribution of the laying intervals of eggs

Egg Number	Number of eggs laid after (days)										Mean (days)	Standard deviation days
	1	2	3	4	5	6	7	8	9	10		
2	32	149	18	3	1						1.97	0.59
3	26	132	33	8	3	1					2.17	0.79
4	15	77	22	5	1		1			1	2.29	1.13
5	1	11	4	2							2.57	1.09

Table 18: Clutch-size at Ferozpur Bangal Heronry, 1983

Month	Clutches studied	Clutches of 3 eggs	4 eggs	5 eggs	Mean clutch-size (eggs)	Standard deviation (eggs)
May	30	8	18	4	3.86	0.61
June	19	11	7	1	3.47	0.59

Table 19: Clutch-size at Khuda Lahora Heronry, 1983

Month	Clutches studied	Clutches of 3 eggs	4 eggs	5 eggs	Mean clutch-size (eggs)	Standard deviation (eggs)
May	15	4	10	1	3.80	0.54
June	10	6	4	0	3.40	0.80

Table 20: Clutch-size at Dhanas Heronry, 1983

Month	Clutches studied	Clutches of 3 eggs	4 eggs	5 eggs	Mean clutch-size (eggs)	Standard deviation (eggs)
May	17	4	11	2	3.88	0.58
June	14	8	6	0	3.42	0.49

Table 21: Clutch-size at Bharaunjian Heronry during, 1984

Month	Clutches studied	Clutches of 3 eggs	4 eggs	5 eggs	6 eggs	7 eggs	Mean clutch-size (eggs)	Standard deviation (eggs)
May	45	12	24	8	0	1	3.97	0.80
June	22	12	8	2	0	0	3.54	0.65

Table 22: Clutch-size at Maloya Heronry during 1984

Month	Clutches studied	Clutches of 3 eggs	Clutches of 4 eggs	Clutches of 5 eggs	Mean clutch-size (eggs)	Standard deviation (eggs)
May	18	4	11	3	3.94	0.62
June	13	8	5	0	3.38	0.48

4.56 TIME OF LAYING

Time of egg-laying in ten clutches was studied at 6 A.M. and at 7 P.M. Out of the 39 eggs laid in these clutches, 38 (97.4%) eggs were found in the morning visits while 1 (2.5%) egg was found in an evening visit. It can thus be interpreted that the eggs are generally laid during the night or early in the morning.

4.57 CLUTCH

4.571 *Clutch-size*

Clutch-size in case of *B.i. coromandus* is determinate as the second and third eggs removed from clutches of 3, third and fourth eggs from clutches of 4, and fourth and fifth eggs from clutches of 5 did not result in the replacement of eggs. Moreover, in the clutches which lost some of the eggs due to winds during egg-laying or incubation, there was no replacement of eggs.

The clutch-size ranged from 3 to 5 eggs in this study area with an exception of one clutch of 7 eggs found during 1984 Bharaunjian heronry. Clutch-size noted in different heronries during 1983 and 1984 is given in Tables 18, 19, 20, 21 and 22. The mean clutch-size for the year 1983 was 3.63 $\pm$ 0.60 eggs while it was 3.79 $\pm$ 0.74 eggs in 1984. Lack (1968) after quoting Sehuz (1942), Owen (1960) and Lack (1966) considered that clutch-size in Ciconiiformes was close to the number of young for which the parents could find enough food in favourable conditions. In *B.i. coromandus* as the larger broods of five are raised successfully with an exception of one clutch of seven where five of the nestlings died, Lack's statement stands confirmed.

Lack (1954) stated that the average clutch-size in many birds increases with the increased distance from equator towards the north because of geographical differences in food abundance and increased day length towards the north in summer. Average clutch-size of *B.i. ibis* in Southern Ghana (5°N) was 2.6 eggs (Bowen *et al,* 1962). Average clutch-size of Cattle Egret was 2.9 eggs in Senegal (16°N) (Morel and Morel 1961). In Florida (29°N), Jenni (1969) reported the mean clutch-size of Cattle Egret as 3.5 ± 0.07 eggs. In the present study at (30°N) the mean clutch-size is 3.68 ± 0.60 eggs and 3.7 ± 0.74 eggs in 1983 and 1984 respectively. Demente'v and Gladkov (1969) described the clutches of Cattle Egret ranging from five to nine eggs in USSR. From these reports it is evident that the average clutch-size of Cattle Egret certainly increases with the increase in latitude towards north.

In this study area, larger clutches of five are generally laid in the month of May while the smaller clutches of three are more frequent in June. Less availability of food due to the growth of paddy which makes wading almost impossible at the time of late hatching eggs, seems to be the main factor effecting the reduction in clutch-size in the month of June.

4.572 *Egg-loss*

Quite a good number of eggs were lost in the marked nests during the study. During day time and during some night observations,no predation of eggs was observed. The main reason for the egg-loss in this study area is high-speed winds due to gales and dust-storms which cause the swaying of tree branches resulting in egg falls. Egg-loss studied in the three heronries during 1983 was 43.4% at Ferozpur Bangal heronry, 26.3% at Dhanas hernory and 13.1% at Khuda Lahora heronry (Table 23). Khuda Lahora heronry which was protected on two sides by two-storey houses but was exposed on the other two sides, had medium egg-loss. Ferozpur Bangal heronry was a highly exposed heronry,having only one side protected by two-storey houses, suffered the maximum egg-loss. In 1984, Bharaunjian heronry was safer in having two-storey house on one side than Maloya heronry. The egg-loss in Bharaunjian heronry was slightly less 32.6% as compared to the Maloya heronry 35.6% (Table 24). It can thus be stated that the egg-loss in a heronry mainly depends upon its protective location in a village; the more protected heronry suffering minimum egg-loss.

It was observed that in larger clutches of five, all eggs were lost in 23.8% of the cases and one to four eggs in 47.6% of the cases. The percentage of

Table 23: Egg-loss in the three heronries during 1983

Name of heronry	No. of nests marked	No. of eggs laid in marked nests.	No. of eggs lost in marked nests.	Egg-loss in heronry (%)
Ferozpur Bangat	49	182	79	43.4
Khuda Lahora	25	91	12	13.1
Dhanas	31	114	30	26.3

Table 24: Egg-loss in the two heronries during 1984

Name of heronry	No. of nests marked	No. of eggs laid in marked nests.	No. of eggs lost in marked nests.	Egg-loss in heronry (%)
Bharaunjian	67	257	84	32.6
Maloya	31	115	41	35.6

egg-loss decreased with the decrease in clutch-size (Table 25). The loss of more eggs in larger clutches can be correlated with the inability of parents to restrict all the eggs on swaying branches.

4.573 *Replacement clutches*

Of the 39 nests losing all eggs due to winds, 16 (41.0%) were deserted while in 23 (58.9%) egg-laying was again resumed after 8-19 days with a mean of 12.4 ± 4.6 days. These replacement clutches usually carried the same number of eggs as previously laid. This shows that the clutch even if laid for second time is determinate.

4.6 INCUBATION AND HATCHING

4.61 INCUBATION

Incubation starts with the laying of first egg. One change-over takes place every day at any time between morning to evening hours. Night-stays in the nest are not confined to one particular sex. One of the parents stays in the nest while the other roosts in a summer roost situated nearby.

Attentive periods at nest are very high. Usually nests are not left unguarded but at high ambient temperatures i.e. 40°C onwards, there are

Table 25: Loss of eggs in relation to clutch-size

Clutch size	No. of clutches observed	No. of clutches losing one or more eggs	% age of clutches losing one or more eggs	% age of eggs lost	No. of total clutches lost	% age of total clutches lost
3	77	13	16.8	6.0	14	18.1
4	104	34	32.2	16.0	20	19.2
5	21	10	47.6	19.0	5	23.8

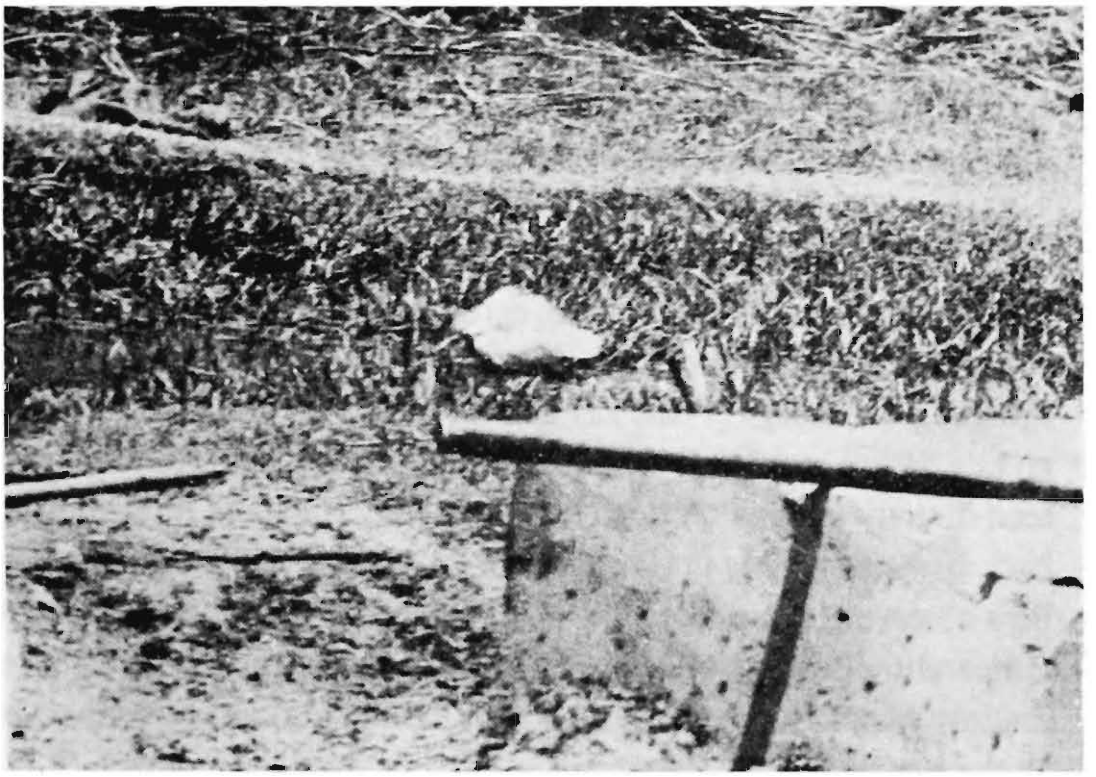


Plate 12. A Cattle Egret dipping its abdominal feathers in water during high ambient temperature for the wetting of eggs.

Plate 13. A shading adult, raising its body above the eggs and pushing its wing bends forward and downward for shading of eggs.

water-sipping and feather-dipping trips. These trips are always of a very short duration. At Palheri heronry, where the water resource was approximately 100 meters away from the observed nesting site of egrets, time noted for 32 trips was 41 - 54 seconds per trip with a mean of 46.2 ± 3.4 seconds. In other heronries where the water resource was 10-20 meters away, these trips were made in less than 30 seconds each. During this trip the nest is left unguarded and the egret flies to the water-resource and lands in shallow water, snatches a sip of water, dips its abdominal feathers by squatting on its legs (Plate 12) andhurriedlyflies back to the nest where it gives a "Rick-rack" call before entering. Sometimes, *B.i. coromandus* was seen directly landing on deep water, floating for some time and then flying back to its nest. Maximum number of water-sipping and feather-dipping trips observed in one case were eight in one day at Palheri heronry when the temperature during noon rose to 48°C in the open. As egrets take dips in shallow waters, some mud also comes in their abdominal feathers by which all the eggs in clutches get soiled

When the temperature rises beyond 40°C the relative humidity in this area falls quite low (8% lowest). In such adverse conditions, the problem of maintaining egg temperature and to reduce water-loss from eggs is solved by the Cattle Egret by taking water in their abdominal feathers and sitting on eggs. This probably acts as a cooling and humidifying device for eggs.

In the present study it was observed that *B.i. coromandus* also shades its eggs by pushing its distal wing bend forward and proximal wing bend downwards (Plate 13). Shading is always observed when the environmental temperature rises above 32°C and is synchronized to the position of sun. From the morning to noon all the egrets in heronry face towards west while shading and towards east from noon to evening. This synchronization is merely meant far saving eggs from exposure to sunlight i.e. ultimately the high temperature.

When the mean-hourly temperatures were plotted against the time spent on incubation and shading per hour (Fig. 19), it was found that at low-mean-hourly temperatures of 28° - 29°C the time spent on incubation was 50 - 54 minutes per hour. At the mean-hourly temperatures of 33° - 34° the incubation was 16 - 21 minutes per hour and at 36°C the time spent on incubation was reduced to nil. On the other hand shading started at mean-hourly temperature of 32.3°C and was highest at 36° - 39°C (51 - 56 minutes per hour). The shading again decreased after 39°C and gave way to

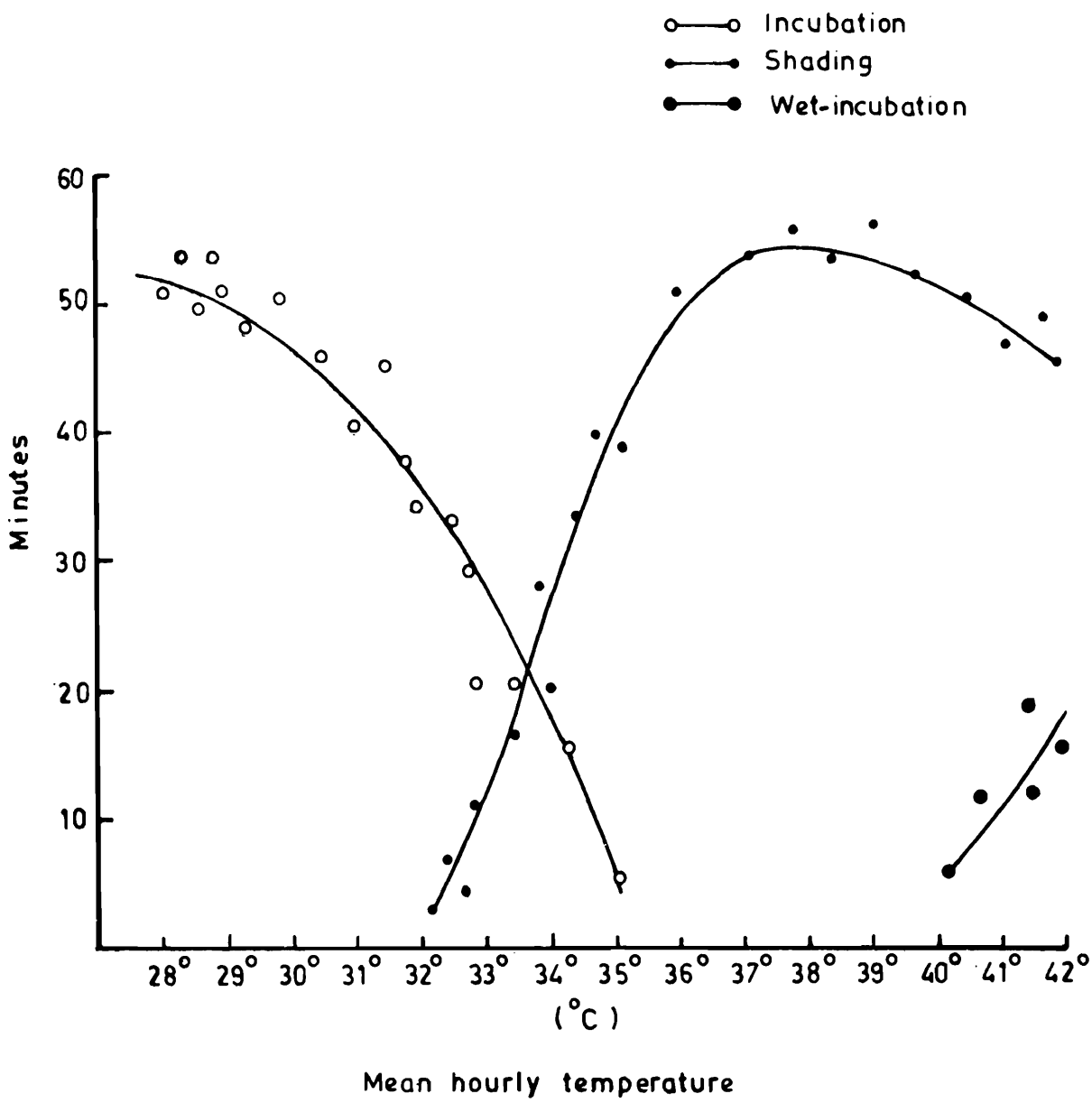


Fig. 19. Variation in incubation, shading and wet-incubation with the ambient temperature.

the wet-incubation (Fig. 19). These findings are relevant when there is no wind. With high wind/gales the egrets try to save eggs by sitting on them irrespective of temperature or humidity prevailing at that time.

4.611 *Incubation period*

Incubation period ranges from 22 to 26 days with a mean of 23.8 ± 0.93 days (Table 26).Jenni (1969) described incubation period of *B.i. ibis* as 22.9 ± 0.04 days which is almost near to the present observations.

4.62 HATCHING

The hatching starts with the pipping of egg. The beak-tip with egg-tooth of the embryo is visible through this window. After pipping, squeaks and chirps can be heard from within the egg. McFarland (1981) recorded such

Table 26: Frequency distribution of incubation period

Total No. of last eggs studied	Incubation period					Mean incubation period (days)	Standard deviation (days)
	22	23	24	25	26		
	days						
172	4	68	43	48	9	23.8	0.93

vocalizations in precocial species such as chickens, ducks and geese. Additional cracks start appearing after the pipping. These cracks appear in an anti-clockwise direction when seen from the broader side of egg (Plates 14 - 22). Half rim is cut by this anti-clockwise cracking. And then the pressure of body by heavy breathing from within the egg leads to the separation of the small circular rim. The hatching took 1 - 2 days after pipping in six observed cases. The final stages of hatching are very fast taking only half to one hour for the hatchling to come out of the egg. The chicks of *B.i. coromandus* have open eyes and are covered with down tracts. As the chicks are covered with down feathers but are unable to leave the nest and are fed by the parents, they can be put under the type semi-altricial described by Welty (1979).

Hatching of eggs in clutches is asynchronous. The eggs hatch almost after the same interval as that of laying.

4.621 *Hatching success*

During 1983, total hatching success in the three heronries was 86.5% while it was 85.8% during 1984 in the two heronries. Hatching success in different heronries during the years of study is given in Tables 27 and 28.

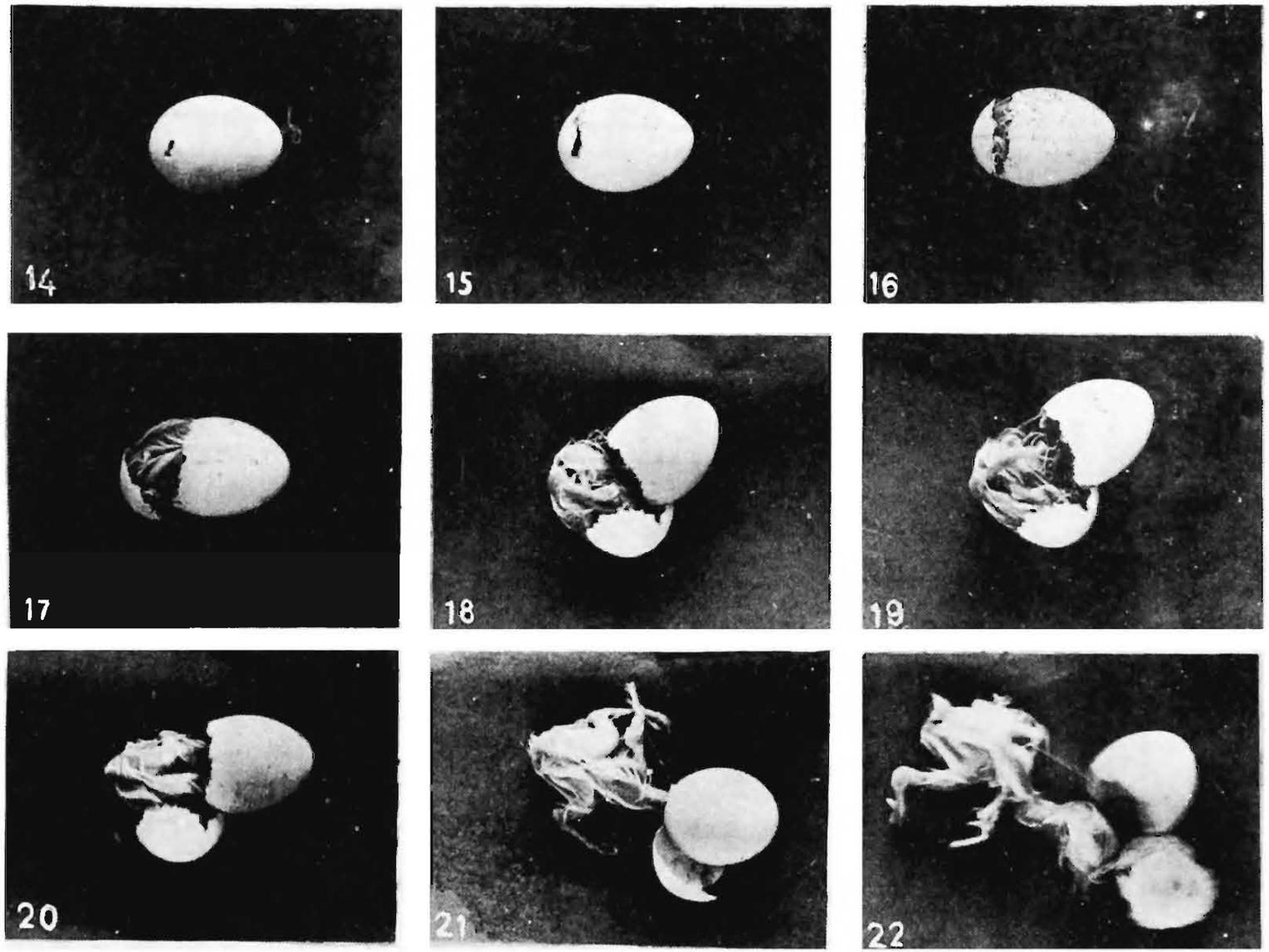
It was observed that due to staggered hatching, the first eggs in clutches hatch before the last ones. The chicks are fed by the parents. These chicks as unable to move, defecate inside the nests. The unhatched eggs in clutches get smeared with the sticky-white droppings of these previously hatched nestlings. Out of the 50 unhatched eggs which were dissected to know the cause of their failure, 42 (84%) had fully developed embryos while in 8 (16%) the development did not start. It can be made out here that hatching failure in most of the cases i.e. 84% is due to the smearing of eggs with the droppings, which blocks all pores in egg-shell and stops the respiration of the embryo near hatching. Rest 16% of hatching failure seems to be the result of over-heating or infertility in eggs.

Table 27: Hatching success in the three heronries during 1983

Name of heronry	No. of marked nests	No. of eggs laid in marked nests (a)	No. of eggs lost (b)	No. of eggs remained after egg-loss (a-b)	No. of eggs failed to hatch (c)	No. of eggs hatched (d)	Hatching sucess = $\frac{d}{a-b} \times 100$
Ferozpur Bangal	49	182	79	103	18	85	82.5
Khuda Lahora	25	91	12	79	9	70	88.6
Dhanas	31	114	13	101	11	90	89.1

Table 28: Hatching success in the two heronries during 1984

Name of heronry	No. of marked nests	No. of eggs laid in marked nests (a)	No. of eggs lost (b)	No. of eggs remained after egg-loss (a-b)	No. of eggs failed to hatch (c)	No. of eggs hatched (d)	Hatching sucess = $\frac{d}{a-b} \times 100$
Bharaunjian	67	257	84	173	26	147	84.9
Maloya	31	115	41	74	9	65	87.8



Plates 14-22. Hatching - starting with the pipping of eggs, more cracks appearing in an anti-clockwise direction, cutting a half rim. Pressure from within the egg by heavy breathing separating the rim and leaving the hatchling free.

It was noted that hatching failure was more in the last eggs of clutches than in the first ones (Table 29). The percentages of eggs that did not hatch were 4.2%, 8.2%, 12.2%, 30.1% and 46.1% in the 1st, 2nd, 3rd, 4th and 5th egg respectively in the clutches observed during study. The last eggs as already described hatch late and the probability of their failure is higher in the presence of continuously defecating nestlings. The failure in the Ist and 2nc egg was due to over heating or infertility in eggs as in these cases the developed embryos were not observed in the failed eggs.

Table 29: Hatching failure in relation to egg numbers in clutches

Egg Number	Number of eggs remained after egg-loss	Number of eggs that failed to hatch	%age of eggs that failed to hatch
1	141	6	4.2
2	133	11	8.2
3	131	16	12.2
4	93	28	30.1
5	13	6	46.1

The eggs which failed to hatch were left in the nests, they were not dropped by parents from the nests. These unhatched eggs were devoured by crows (*Corvus splenders*) later on when the nests were deserted both by parents and fledglings.

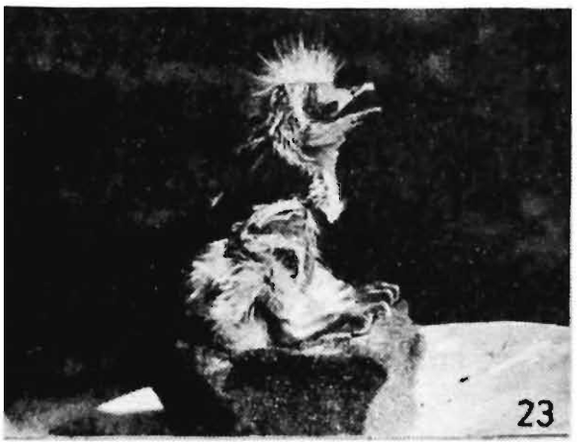
4.7 POSTNATAL LIFE

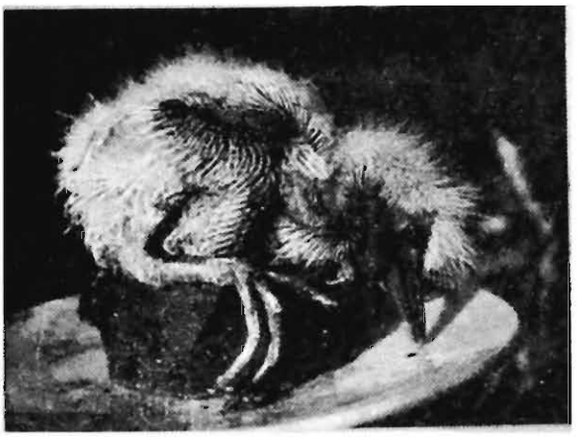
4.71 POST-HATCHING DEVELOPMENT OF CHICKS

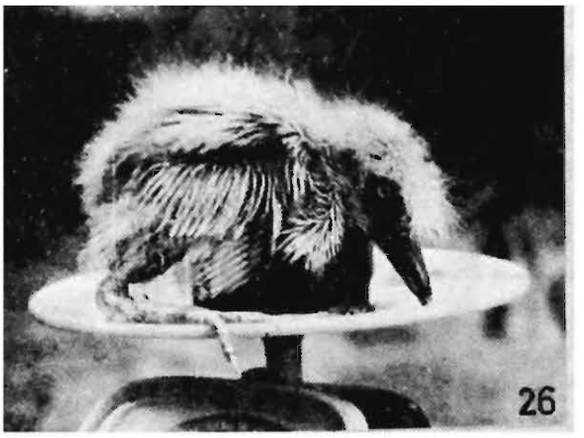
4.711 *Freshly hatched to twelve hours old* (Plate 23)

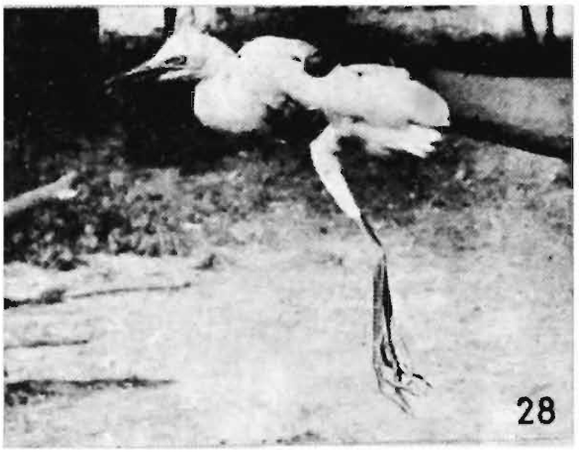
Plumage. Head covered with white-recumbent downs, latter 10-12 mm. long. Body dorsally covered with two tracts of downs. Inner wing margins also beset with downs. Ventral side of body having two sparse tracts of downs. Tail-ridge with very sparse downs.

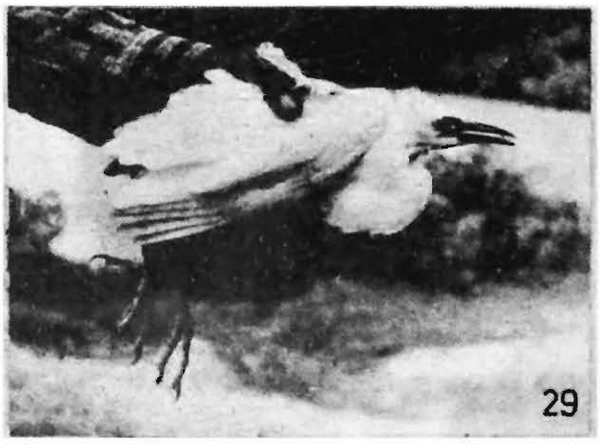
Unfeathered parts. Skin of forehead fleshy; crown pinkish fleshy; eye-ring greenish blue; auriculars fleshy pink. Upper mandibles pale with pinkish tinge, tip of upper mandible light yellow; nostril-arch pale, egg-tooth











Plates 23-29. Growth of the Cattle Egret chicks. 24- one the first day of hatching. 25- one day old chick. 26- three day old. 27- five day old. 28-ten day old. 29-fifteen day old. 30-twenty day old. 31-twenty-six day old.

present, light yellow to white in colour. Lower mandible pale. Mouth lining greenish blue in proximal half and pale in distal half. Iris dusty brown. Neck fleshy pink, sometimes also having greenish tinge on nape; gular pouch and jugulum pinkish in colour. Body greenish dorsally pinkish-skin-coloured ventrally; breast skin coloured; wings pinkish fleshy. Anal region pale. Tarsus fleshy pink. Toes pinkish, undertoes pale. Claws pinkish.

Measurement. Body length - 85 mm.; Wing - 15 mm., Wing extended-76 mm.; Beak - 11 mm., Tarsus - 13 mm., Middle toe-11 mm.

4.712 *One day old*

Plumage. Same as the freshly hatched chick except the downs which are more erect and slightly longer. Maximum length of downs 15 mm.

Unfeathered parts. All parts of body same as in freshly hatched chick except jugulum and gular pouch which start turning yellowish; abdomen turns greenish; colour of iris turns pale whitish; tarsus and toes turn greenish brown.

Measurements. Body length - 115 mm.; Wing - 18 mm., Wing extended-98 mm., Beak - 12 mm., Tarsus - 18 mm., Middle toe - 15mm.

4.713 *Three day old* (Plate 24)

Plumage. Down-tipped quills start emerging from all feather tracts except rectrices.

Unfeathered parts. Skin of forehead greenish; crown pinkish; auriculars greenish. Upper mandible horny with violet tinge, tip of upper mandible yellow; nostril-arch pinkish. Lower mandible horny, yellow at tip. Lores horny-yellow. Mouth lining blackish blue. Neck greenish. Body dirty green dorsally. Breast pinkish green. Abdomen fleshy pink with greenish tinge. Wings greenish. Anal region yellowish green. Tarsus pinkish light-green. Toes pinkish horny. Claws pinkish white.

Measurements. Body length - 160 mm.; Wing - 22 mm., Wing extended - 120 mm., Beak - 16 mm., Tarsus - 22 mm., Middle toe - 20 mm.

4.714 *Five day old* (Plate 25)

Plumage. All feather tracts except rectrices have spine like quills emerging. Longest quill spines on different tracts: head - 3 mm., back -7 mm., primary - 5 mm., secondary - 5 mm., crural - 7 mm.

Unfeathered parts. Head with dirty green auriculars, crown, and forehead. Upper and lower mandible horny with yellow tip. Mouth lining black. Lores horny yellow. Iris light yellow. Dorsal body dirty green. Breast violet. Abdomen light green. Tarsus and toes greenish. Claws black at base, white at tip.

Measurements. Body length - 220 mm.; Wing - 41 mm.; Wing extended-182 mm., Beak - 23 mm.; Tarsus - 27 mm., Middle toe - 30 mm.

4.715 *Ten day. old* (Plate 26)

Plumage. Tufts of feathers present on quill spines in all regions except on head and tail. Longest tufted spines in different tracts; back - 25 mm.; primary - 15 mm.; secondary - 16 mm.; head - 6 mm., neck - 10 mm., crural-11 mm.; abdominal - 10 mm., rectrix - 3 mm.

Unfeathered parts. Same as of five days old chick.

Measurements. Body length -250 mm.; Wing -76 mm.; Wing extended -180 mm., Beak - 30 mm., Tarsus - 36 mm.; Middle Toe-41 mm.;Tail -3 mm.

4.716 *Fifteen days old* (Plate 27)

Plumage. Feather tufts present on all the quills in different tracts. The longest feather in different tracts: Scapular - 40 mm.; head - 10 mm.; neck -20 mm., primary - 35 mm., secondary - 40 mm.; abdominal - 20 mm.; rectrix - 7 mm.

Unfeathered parts. Forehead, auriculars and crown reddish brown. Iris light yellow. Lores horny. Mandibles black, yellow at tip. Body greenish brown dorsally and brownish ventrally. Tarsus black on anterior broad surface, greenish yellow on posterior ridged surface, scales well formed on tarsi and toes. Toes black, undertoes light yellow. Claws black.

Measurements. Body length - 320 mm.; Wing - 90 mm., Wing extended-400 mm.; Beak - 36 mm., Tarsus - 50 mm., Middle toe - 52 mm., Tail -7 mm.

4. 717 *Twenty day old* (Plate 28)

Plumage. All feather tracts covered with tufted feathers to feathers nearing complete development. Longest feathers: back - 72 mm.; head -12 mm.; neck - 34 mm.; primary - 82 mm.; secondary - 57 mm., rectrix

-20 mm. Two pairs of powder down patches, breast and crural start appearing. The powder downs, white and hair like.

Unfeathered parts. Forehead, auriculars and crown fleshy brown. Mandibles black with yellow tip. Iris light yellow. Lores grey. Tarsus with anterior broad surface, black undertoes greenish yellow. Claws black.

Measurements. Body length - 355 mm., Wing - 125 mm.; Wing extended - 565 mm.; Beak - 43 mm.; Tarsus - 52 mm.; Middle toe - 56 mm.; Tail - 20 mm.

4. 718 *Twenty-six day old* (Plate 29)

Plumage. All feather tracts covered with feathers nearing complete development to those fully developed. Longest feathers on different tracts: back - 98 mm.; head - 15 mm.; neck - 35 mm.; primary - 120 mm.; secondary - 82 mm.; rectrix - 30 mm. Powder down patches much prominent with longest powder down 8 mm.

Unfeathered parts. Same as of twenty days old chick except beak which is grey at base, black in the middle and yellow at tip. Lores black.

Measurements. Body length - 420 mm., Wing - 181 mm.; Wing extended - 690 mm.; Beak - 46 mm.; Tarsus - 67 mm.; Middle toe - 57 mm.; Tail - 20 mm.

The beak of fledglings starts turning yellow after 30 - 35 days of age and by the time they reach 45 - 55 days of age, the beak becomes fully yellow. As after 29 - 35 days of age the fledglings start flying and going to fields for feeding, they can be observed with partly yellow beaks feeding in fields along with adults.

4. 72 GROWTH OF YOUNG

Growth in the weight of nestlings showed that first four gained weight almost in the same fashion at the end of 13 days age (Table 30,Fig. 20). Fifth nestling grew slow and gained less weight at relative ages than its older siblings.

4. 73 BROODING AND FEEDING OF YOUNG

The brooding is as careful as incubation. Shading and application of brood-patch to the young continue and varies with ambient temperature. It was observed that cases having 2 - 3 nestlings were brooded for less number of days as compared to the larger broods of 4 and 5. Twelve cases having

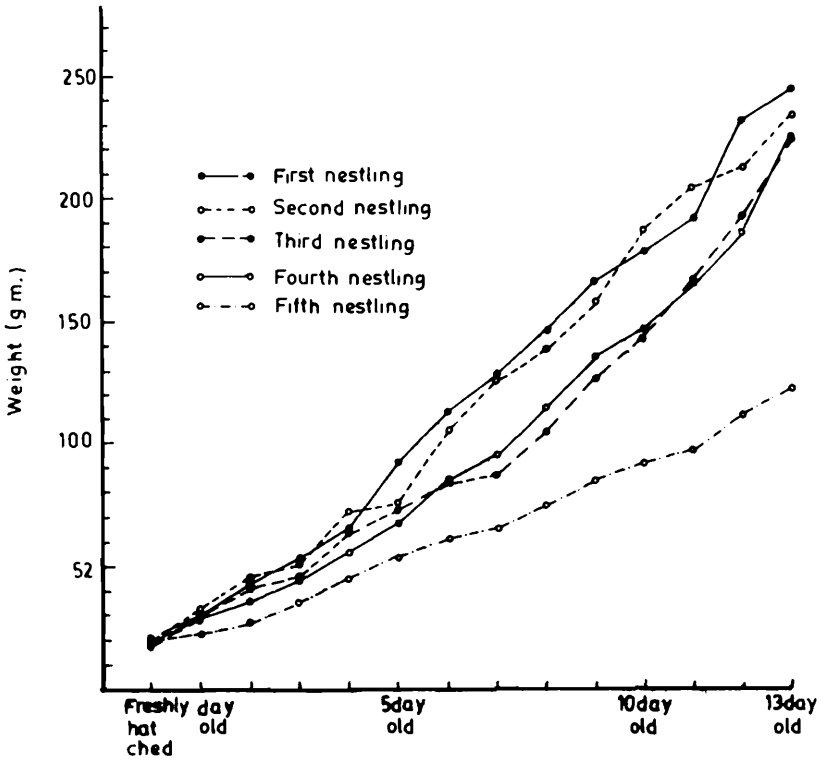


Fig. 20. Growth of the nestlings.

two nestlings had a mean of 10.8 ± 1.1 days of brooding. In sixteen cases of 3 nestlings, mean brooding time was 11.6 ± 1.8 days and in nine cases of 4 nestlings mean brooding time was 13.4 ± 2.1 days. In three cases of 5 nestlings mean brooding time was 15.7 ± 3.2 days. In the later days of brooding when the nestlings grow in size, it becomes difficult for the parents to stay in nest because of food getting efforts of the young. Therefore, one of the parents perches a meter or two away from the nest and guards it.

Feeding of nestlings starts 7-8 hours after hatching. The parent, present in the nest, regurgitates a bolus of food in the nest and the nestling feeds on it. When the nestling grows 6 - 8 days old it starts holding the beak of parent in a cross-wise fashion and starts getting food directly from the beak. Food getting call "zit-zit" is given by young from the very first day after hatching. When the nestlings are more than fifteen days, they usually wait outside the nests for parents. Food taking in these chicks was observed on the branches outside the nests. Both the parents feed the young with alternate feeding trips. Usually 2 - 3 change-overs of adults take place when the chicks are brooded. In the chicks ranging from 15 to 20 days of age, maximum number of food trips by both the parents were noted to be 8 in one day.

Table 30: Growth in weight of nestlings

	First nestling			Seond nestling			Third nestling			Fourth nestling			Fifth nestling		
Age	Number studied	Mean (gms.)	S.D.	Number studied	Mean (gms.)	S.D.	Number studied	Mean (gms.)	S.D.	Number studied	Mean (gms.)	S.D.	Number studied	Mean (gms.)	S.D.
Freshly hatched	28	21.2	1.97	27	20.6	1.83	23	19.8	1.88	19	20.9	2.01	4	20.7	2.53
One day old	26	30.6	2.81	24	31.8	2.80	24	28.1	2.68	18	29.8	3.25	4	23.4	4.28
2-day old	29	43.3	4.92	28	44.5	5.59	23	41.4	4.21	18	37.2	5.82	4	27.8	6.87
3-day old	31	53.1	7.42	31	51.2	7.01	23	47.3	8.67	18	44.9	10.10	4	36.4	8.91
4-day old	27	64.8	8.56	26	71.1	9.05	23	61.9	11.89	17	55.1	13.82	3	44.7	13.29
5-day old	26	92.7	10.36	27	74.2	11.56	21	71.4	10.22	17	68.3	12.12	3	53.4	15.91
6-day old	31	113.0	14.51	27	104.4	13.21	21	82.8	11.82	15	84.2	15.87	3	60.1	16.83
7-day old	32	128.1	17.30	27	125.1	16.71	21	87.5	15.45	15	95.8	16.42	3	66.8	19.34
8-day old	29	146.2	16.07	26	139.8	17.82	22	105.3	16.42	14	114.2	19.82	3	75.2	21.83
9-day old	28	166.1	21.50	25	158.3	19.10	22	107.6	18.92	14	135.4	17.85	3	86.4	17.82
10-day old	25	178.1	18.21	24	188.3	20.21	19	151.9	24.81	14	148.6	27.82	3	92.7	16.71
11-day old	26	190.8	19.31	23	205.3	21.32	19	175.2	19.21	13	166.7	25.75	2	98.1	11.89
12-day old	23	231.6	26.21	22	212.4	24.12	18	192.1	26.21	13	187.2	24.85	2	112.2	14.74
13-day old	22	244.5	23.31	22	233.7	22.02	17	220.2	25.85	12	22.1	28.23	2	123.8	15.65

4.74 NESTLING MORTALITY

The main chick mortality is caused by the falls and strangling in the tree branches. The falls are caused when the chicks enter the territory of other egrets where the adults peck at them so that the chicks fall to entangle themselves in thorny branches of *Acacia arabica*. Falling from such a height causes immediate death and entangling in the branches without movement starves them to death. Usually there are no falls in the chicks older than 25 days; when they encounter the adults the chicks at that age are capable of fleeing from the situation and save themselves.

During 1984 at Bharaunjian heronry nestlings were attacked by the red mites of genus *Dermanyssus*. Under wings, scapular region, neck, breast and crural region of nestlings were densely infested by the mites. The red mite attack claimed the life of 21 nestling in six broods at Bharaunjian heronry. Attacked nestlings turned pale and weak, their eyes opening with difficulty and in the later stages they could not even hold their necks up. All the nestlings in six broods died before they could pass the age of ten days. In other heronries, mild attack of red mites was observed in some of the cases but it never reached the stage where it could cause a death.

4.75 BEHAVIOUR OF THE YOUNG

Comfort activities develop in the nestlings with their subsequent growth. Gular flutter is performed by the nestlings during which the gular pouch is continuously fluttered. This activity is present in the nestlings from the very first day after hatching. Gular flutter is performed with open beak and is frequent after the ambient temperature rises above 34°C. As the water is evaporated through open beaks this activity is the cooling device of nestlings during high ambient temperatures.

The chicks start moving their wings up and down during begging calls. When they grow more than twenty days old, they start moving to the tree tops and flap their wings vigorously. Moreover, they start chasing their parents for food resulting in small leaps and then small flights. These juveniles start flying when they are 29 to 32 days old.

4.76 NESTLING PERIOD

Nestling period noted for 42 ringed nestlings was 29-35 days with a mean of 31.6 ± 1.98. As the flight of nestlings is gained at the age of 29-32 days, they leave their nest after becoming fully capable of flight. These juveniles were seen following adults during their first visits to the fields.

Table 31: Nestling success and Breeding success in the three heronries during 1983

Name of heronry	Number of nests studied	Number of eggs laid	Number of eggs lost	Number of unhatched eggs	Number of chicks died	Number of chicks passed age of 30 days	Nestling success (%)	Breeding success (%)
Ferozpur Bangal	49	182	79	11	18	74	80.4	40.6
Khuda Lahora	25	91	12	9	12	58	82.8	63.7
Dhanas	31	114	30	12	11	61	84.7	53.5

Table 32 : Nestling success and Breeding success in the two heronries during 1984.

Name of heronry	Number of nests studied	Number of eggs laid	Number of eggs lost	Number of unhatched eggs	Number of chicks died	Number of chicks passed age of 30 days	Nestling success (%)	Breeding success (%)
Bharaunjian	67	257	84	26	52	95	64.6	36.9
Maloya	31	115	41	9	13	52	80.0	45.2

Afterwards they were also observed moving independently. These juveniles returned to their nesting site in the evening to get feed from the parents. Skead (1966) described this period in which the nestlings return to their nests after their first departure as post-nestling period. In case of *B.i. coromandus* the post-nestling period ranges 21-27 days. During post-nestling period, the nestlings either roost on the branches near their nest or they roost in summer roosts.

4.77 NESTLING SUCCESS AND BREEDING SUCCESS

Nestling success in case of *B.i. coromandus* ranged from 64.6% to 84.7% (Tables 31 and 32). Higher nestling success in this case is due to the absence of any serious predator and the presence of ample food in this area. The lowest observed nestling success (64.6%) was at Bharaunjian heronry where red mite attack caused a considerable chick mortality.

Breeding success of *B.i. coromandus* during the years 1983 and 1984 is given in Tables 31 and 32 The mean breeding success in the three heronries during 1983 was 49.8%. During 1984 the mean breeding success in two heronries was 42.2%. The reason for this reduction in breeding success was the red mite attack at Bharaunjian heronry.

5. FEEDING ECOLOGY

5.1 FORAGING BEHAVIOUR

The foraging behaviour of the Cattle Egret is summarized in Fig. 21

Slow walking is the most frequently employed foraging behaviour by the Cattle Egret. Due to ephemeral and patchy food resources, this behaviour is the most practical. While walking, each step is accompanied with co-ordinating forward or backward movement of neck. Though this bobbing is not considered as a feeding behaviour, yet many authors (Welty 1979, for example) stated that it helps in object localization. Sometimes, walking egret stands and peers over (Fig. 22) for food. The egret searches under the stones for food and sometimes turns them over and inspects their underside; this behaviour is called flipping. At times, the egret jumps after the jumping grasshopper.

Often, running is associated with slow walks, frequent during flock feeding, obviously due to competition. Commonly, the egret uses a combination of stand and wait and slow walking behaviour for foraging, this combination can be called as walk and wait. The Cattle Egret also catches

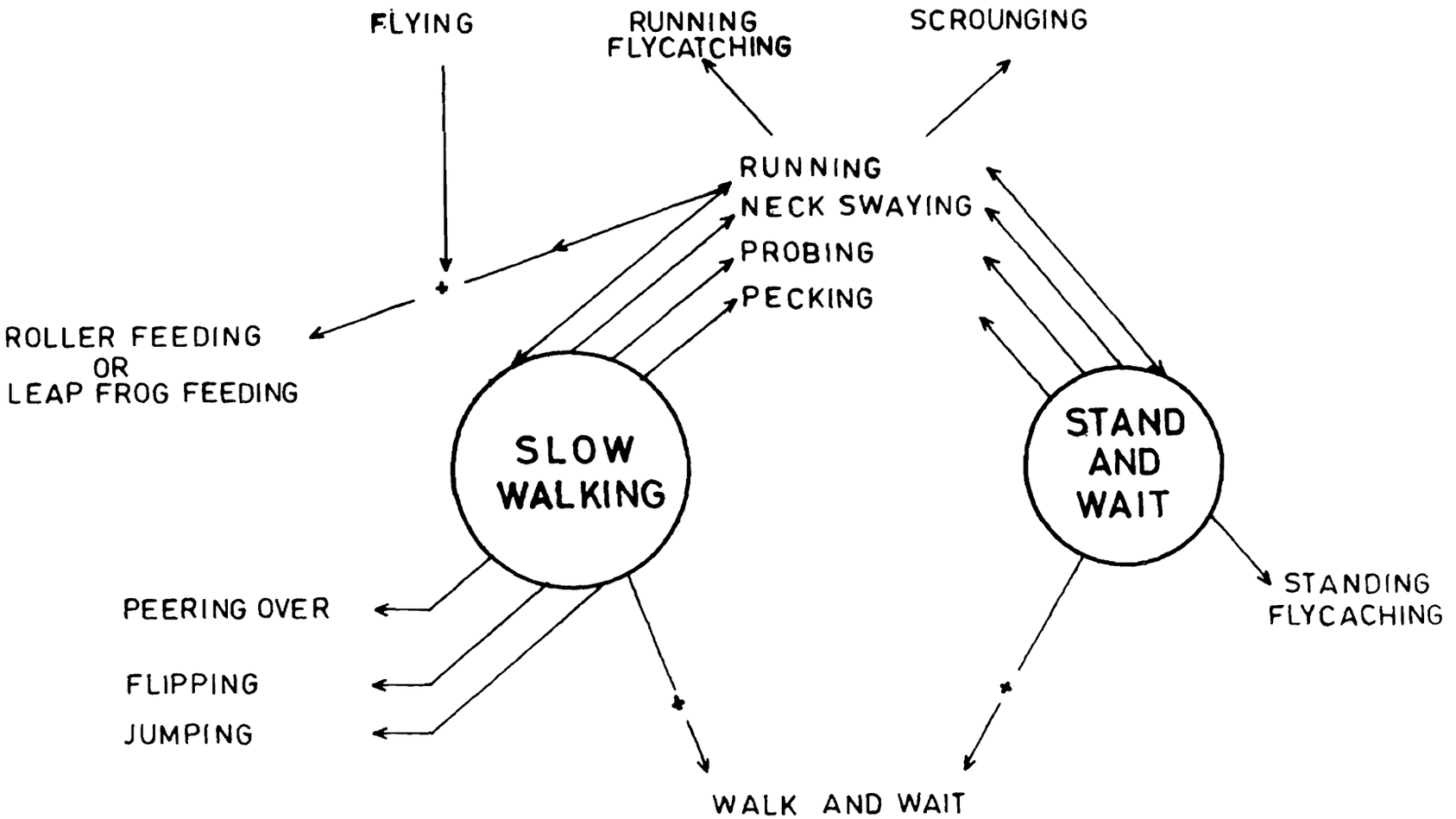


Fig. 21. Foraging behaviour of the Cattle Egret.

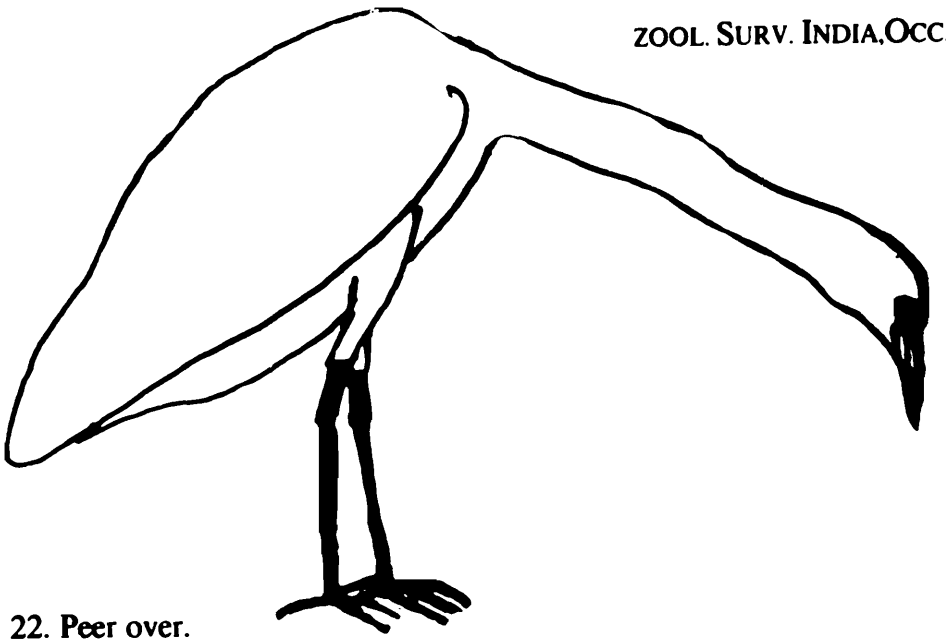


Fig. 22. Peer over.

flying prey while standing; this behaviour is called standing flycatching. The egret, sometimes, runs after flying prey. This behaviour can be termed as running flycatching.

An important aspect of the Cattle Egret foraging is neck swaying. Based on eleven different observations (each of 10 minutes duration), neck swaying occurred 32 times which resulted in 26 pecks, pecking success was 76.9%. We are of a view that neck swaying assists in making correct aim at the prey.

The Cattle Egret mostly pecks i.e., picks up prey from the substratum. Sometimes, it probes shallowly again and again beneath the surface of soil for food. Siegfried (1971c) named it probing.

The Cattle Egret seeks its prey mainly monocularly, using binocular vision in a final pursuit. As some pupae are present in diet (Table 38), it appears that movement of prey is not the only criterion for recognition of potential prey. The prey is secured by a rapid bill thrust. Siegfried (1971c) stated that *B.i.ibis* has"fixed action patterns for hunting and capturing food; and that the stimuli eliciting these become more refined through learning and habituation on the part of the individual"

The handling time of the prey was observed to be less than 1 second to 15 minutes, depending upon the prey size. Small prey is swallowed immediately, but large prey is either pecked to death or reduced to smaller portions or ducked several times in available water before swallowing. This ducking presumably makes swallowing easier. Frequently, the bill is dipped in water after a successful peck. This bill dipping eases the food passage (Kushlan 1978). Similar bill dipping sometimes occurs after an unsuccessful peck; may be this is a redirected behaviour.

There is no set pattern of arrival of birds to the foraging ground. They may arrive singly or in groups (mostly 2-3). Sometimes, they will even gather on tree before alighting on ground. The birds, at times, gather on ground (or on trees) to rest and preen. This is more so during mid-day than at other times.

The Cattle Egret itinerantly searches for suitable foraging sites. The estimates of maximum distance (in km) travelled by *B. ibis* in search of foraging site are 19.3 (Craufurd 1966, Skead 1966), 25.8 (Hopkins and Murton 1969), and 29 (Siegfried 1971c). At the study site, Surajpur, the egrets generally travelled a distance of 1-2 km and a maximum of 10 km in search of a foraging site.

5.2 FORAGING STRATEGIES

5.21 HABITAT SELECTION

Apparently, the Cattle Egret will feed in highly beneficial habitat. To search for such habitat, it uses many tactics. Such tactics used by wading birds, have been discussed by Kushlan (1981).

A complete habitat selection by the Cattle Egret during different months, based on incidence of encounter is given in Table 33. From the table it is evident that the Cattle Egret is predominaitly a terrestrial forager. Its preference for terrestrial habitat can be due to the following reasons: (a) It faces negligible competition from other herons. (2) In terrestrial habitat grazing cattle make foraging easier. (c) Its bill is smaller (71.09 $\pm$ 5.63 mm.) as compared to other herons. The herons with smaller bill prefer terrestrial habitat (Kushlan 1978).

In terrestrial habitat, it generally prefers irrigated pastures to dry pastures. Based on data gathered from 10 km^2 survey in July, 56.29% egrets fed in irrigated pastures (Table 34). The reason being that the gravitational irrigation disturbs and flushes the insects from their hiding places, thus making them visible to the egrets. On a few occasions the Cattle Egrets were observed actually waiting for irrigation to start.

The Cattle Egret was also observed feeding on refuse dumps, such foraging habitat has been reported earlier by Pomeroy (1975), Feare (1975), Schupp (1976), Dean (1978) and Ali and Ripley (1983). Probably, abundant insects out there attract the Cattle Egrets to such habitats. Sometimes the Cattle Egret perches on tree trunks to catch insects (Reid

Table 33: Habitat selection by the Cattle Egret during different months

Habitat	Percentage of Cattle Egrets observed											
	Jan.	Feb.	Mar.	Apr.	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Irrigated and dry pastures	95.8	98.2	97.8	70.0	96.9	92.8	82.8	99.2	95.5	87.8	97.4	93.7
Ditches, ponds rivulets, paddy fields	4.2	1.8	—	—	3.1	7.2	17.2	0.8	4.5	12.2	—	6.3
Marshes	—	—	2.2	30.0	—	—	—	—	—	—	2.6	—

Table 34* : Habitat selection by the Cattle Egret during July. Data gathered by 10 km² survey in July

Habitat	Number of the Cattle Egrets encountered	Percentage of the Cattle Egrets encountered
Irrigated Pasture	255	56.29
Dry Pasture	96	21.19
Paddy fields	98	21.63
Ditches/Ponds	2	0.44
Marshes	2	0.44

*Data not included in Table 33.

1955, Monga and Pandya 1984, pres. obs.). Meyerriecks (1960a) reported a similar behaviour in which the egret perched on fences and roofs to capture insects.

As already mentioned, in this area, the Cattle Egret faces very little competition from other herons, as all other herons of this area are predominantly aquatic foragers. However, during breeding season, the Cattle Egret, the Little Egret, and the Pond Heron share a foraging habitat i.e. paddy fields. The data gathered from 10 km² survey in July (Table 35) revealed that 21.63% of the Cattle Egrets, 88.09% of the Little Egrets and 88.52% of the Pond Herons fed in paddy fields.During this season there is slight overlap in their diet also (unpubl. obs.). This competition, under normal conditions, has no impact on the biology of the Cattle Egret.

Table 35: Habitat overlap of the Cattle Egret, the Little Egret and the Pond Heron during July. Data gathered by 10 km² survey in July.

Habitat	Number of the Cattle Egrets encountered (%)	Number of the Little Egrets encountered (%)	Number of the Pond Herons encountered (%)
Dry Pasture	96(21.19)	0	1(1.63)
Irrigated pasture	255(56.29)	2(4.76)	1(4.91)
Paddy fields	98(21.63)	37(88.09)	54(88.52)
Ditches/Ponds	2(0.44)	1(2.38)	2(3.27)
Marshes	2(0.44)	2(4.76)	1(1.63)

5.22 FLOCK FEEDING

Data gathered from 209 observations on 1278 Cattle Egrets revealed that 68.4% of the times the egrets fed in flocks, and solo for rest of the times. Its conspicuous white plumage is an important device in promoting gregarious behaviour (Siegfried 1978). It has been postulated that its characteristic single-species flock feeding is evolved due to its patchily distributed food (Thorpe 1956, Hinde 1961).

Many theories are put forward to explain possible advantages of the flock feeding. These have been reviewed by Scott (1984).

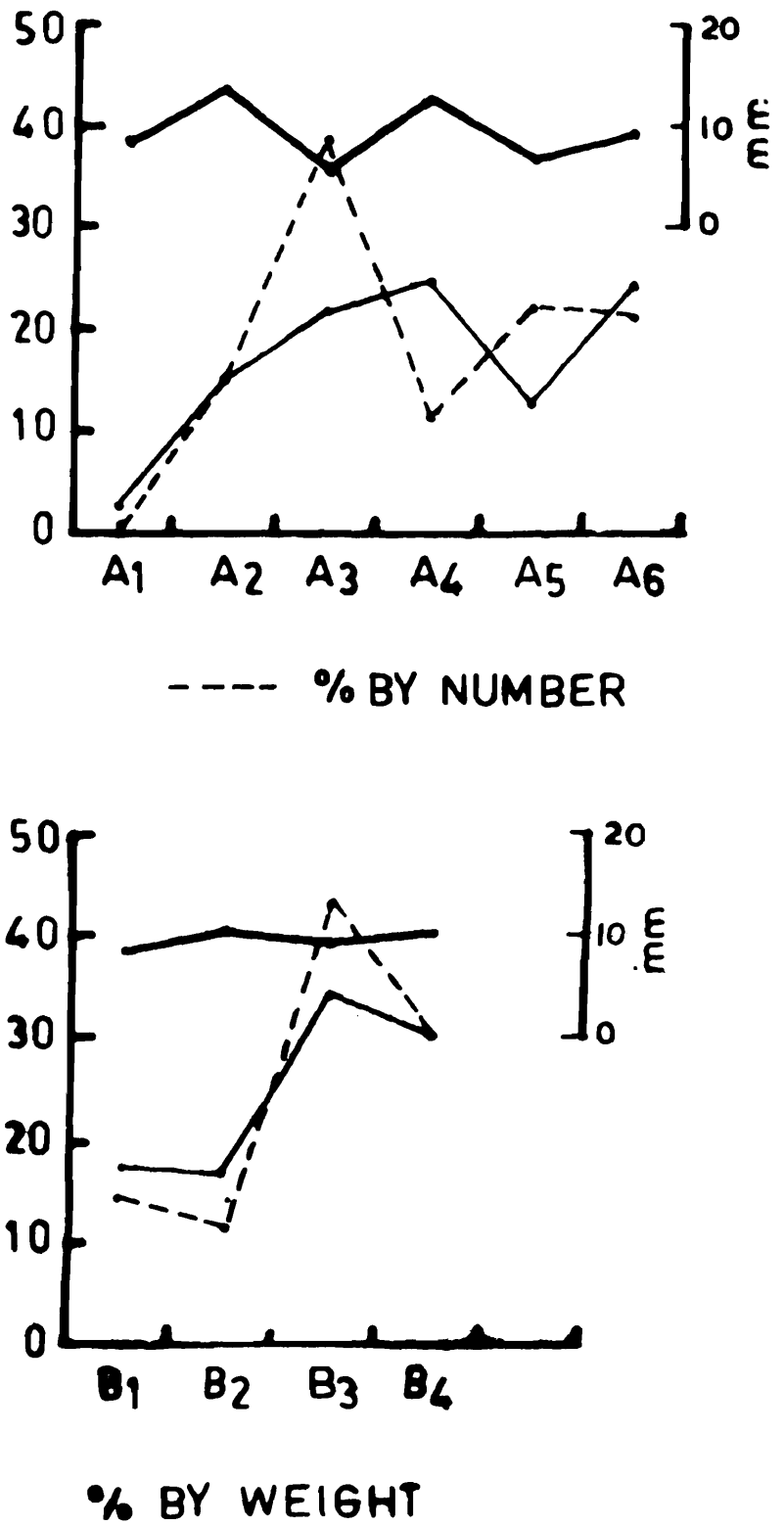
From the data gathered by 2 minute paired observations (Table 36), it is evident that pecking success of the egrets feeding in flocks was higher than of the solo feeders in the same habitat. Thus, the flock feeders are able to gain more energy as food intake than the solo feeders.

On two occasions, six and four flock feeding individuals were shot, after one hour of flock feeding, to study the factors affecting the amount of food consumed by the flock feeders. Firstly, these individuals were weighed, because it has been postulated (by Siegfried 1972b) that, in general, older Cattle Egrets have more weight than the younger ones. Secondly, their tarsal length (in mm.) was measured to have an estimate of their size. Their stomach contents were taken out and analysed. The data of analysis of food of these birds in terms of mean length, percentage of number and weight of food items consumed are given in Figs. 23 and 24. Fig. 23 has data of six

Table 36: Foraging efficiency of the Cattle egret feeding in flocks and solitarily (based on 2 min. paired observations)

	In flocks	Solitarily
Minutes observed	178	178
Pecks	894	980
Successful pecks	736	738
Unsuccessful pecks	158	242
* Pecking success	82.32%	75.30%

$$\text{* Pecking success} = \frac{\text{Successful pecks}}{\text{Total pecks}} \times 100$$



Figs. 23-24. Amount of food consumed by the flock feeders. 23. Data of six individuals, 24. Data of four individuals.

invididuals A_1 (weight = 325 g., tarsal length = 90 mm.), A_2 (325 g., 82 mm.), A_3 (335 g., 85 mm.), A_4 (355 g., 89 mm.), A_5 (360 g., 85 mm.), A_6 (400 g., 93 mm.). Fig. 24 has data of four individuals, B_1 (265 g., 81 mm.), B_2 (295 g., 89 mm.), B_3 (350 g., 86 mm.), and B_4 (360 g., 88 mm.). From the figures it is apparent that there is no impact of weight (i.e. age) and tarsal length (i.e. size) of the individual on the size and amount (both number and weight) of food items consumed by it. Thus, it appears that in flocks the Cattle Egret feeds by opportunist scrambling.

The Cattle Egrets formed flocks ranging from 2-50 individuals. The frequency distribution of the flock size is given in Fig. 25. Most frequently, the Cattle Egrets formed flock with 2-7 individuals. The mean flock size was 8.4 ± 7.9.

Frequently a low intensity "Kaaah" (normally with 2-3 notes) is given by the egret joining the flock. Similar high intensity call is given during Foward Display and fights. Perhaps this call helps in warning the conspecifics and results in avoiding unnecessary fights. There can be four possibilities when intruder attacks defender of the feeding zone (Fig. 26). Rarely, a flock feeding egret runs and catches a prey sighted by its conspecific; this behaviour is called scrounging (after Scott 1984).

The flock movements or the Cattle Egret are generally highly asynchronous. But this is not so in leap-frog feeding (also known as roller feeding), in which all birds advance towards one direction, with those at back continually flying over the heads of others to feed in front rank. This feeding is not so common in the area under study. Two views are given to explain this behaviour. Meyerriecks (1960a) stated that this behaviour helps in improving feeding opportunities for each bird. Siegfried (1971c) stated that it helps in maintaining contact with other individuals in tall grass. As we observed this behaviour mostly while the egrets were following a ploughing tractor or a plough. Meyerriecks view seems to be more plausible.

The Cattle Egret sometimes forms mixed - species flocks with the Indian Pond Heron, the Little Egret, the Median Egret, the House Crow, the Red-wattled Lapwing, the Bank Myna, the Common Myna, the Pied Myna, and the Brahminy Myna.

5.23 FORAGING WITH ASSOCIATES

While foraging, the egret is often associated with associates (mainly mammals and farm machinery). Its association with cattle leads to its name.

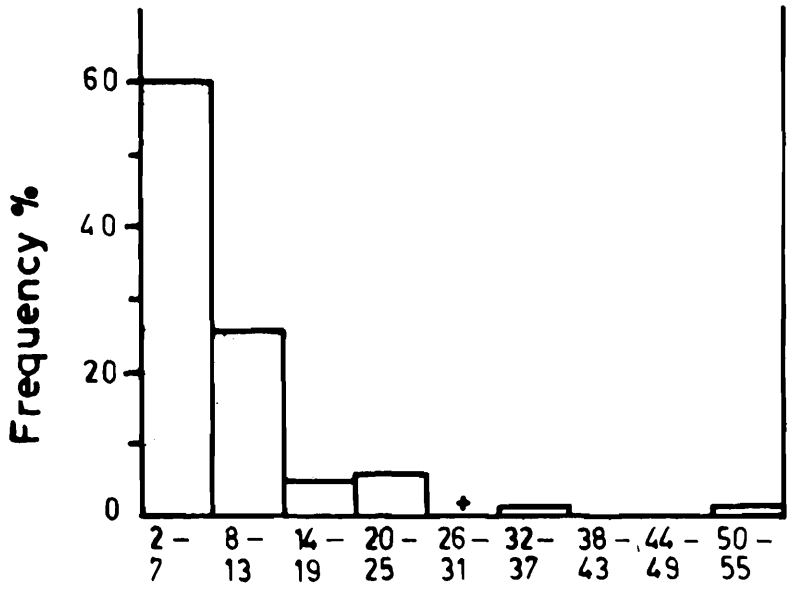


Fig. 25. Frequency distribution of the flock size.

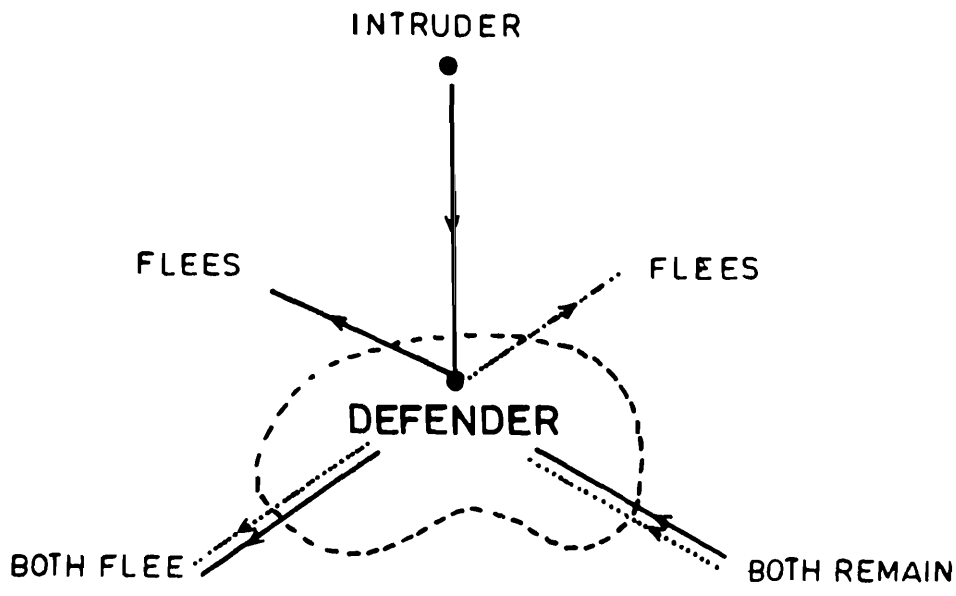


Fig. 26. Four possibilities of tresspassing into a feeding zone.

Blaker (1971) hypothesized that the range expansion of the Cattle Egret is related to expanding cattle farming. Possibly, association of the Cattle Egrets with mammals originated with non-domestic species. Siegfried (1978) postulated that due to its foraging behaviour and habitat selection, the Cattle Egret is preadapted for an association with mammals.

The reported associates of the Cattle Egret are given in Fig. 27. The present study reports its association with the Little Egret, to which it was observed associated in marshes. The Cattle Egret followed the Little Egret, which served as a beater for the former.

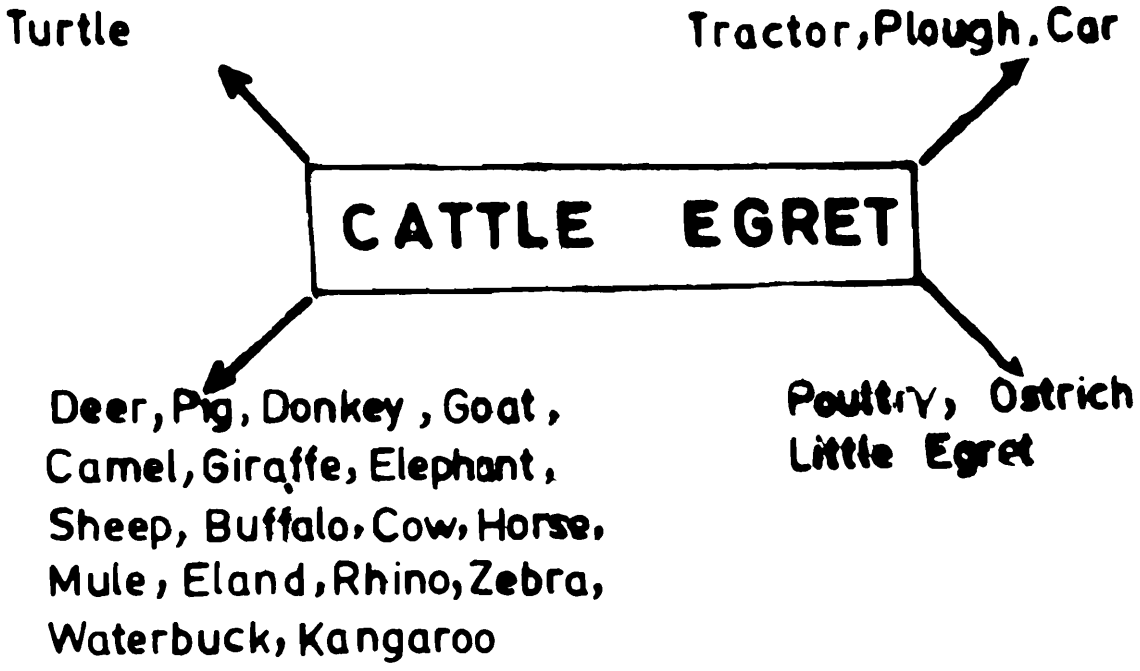


Fig. 27. Reported associates of the Cattle Egret.

During the present study, out of 1278 Cattle Egrets observed, 30.04% were associated (by criterion of Heatwole 1965) with cattle (mainly buffaloes) or agricultural machinery. The month wise association of Cattle Egret in percentage is given in Fig. 28. From the figure it is evident that association was more during the breeding season. Two factors seem to lure egrets more to the cattle during this season. Firstly, in these months the grasses (where the cattle usually feed) harbour plenty of grasshoppers (main food during breeding season, Sodhi and Khera 1984) which are disturbed by the foraging cattle, thus making them visible to the egrets. Secondly, due to heat and rains, large number of dipterans are attracted towards cattle; these serve an easy prey for the egrets.

The associated egrets spend less energy in search of prey and gain more energy as food intake in the same habitat (Rand 1954, Heatwole 1965, Dinsmore 1973, Grubb 1976, Thompson *et al.* 1982). An experiment

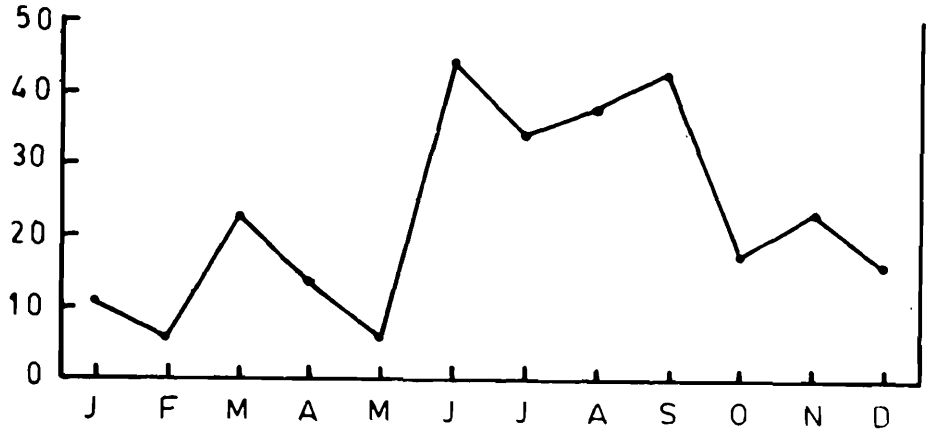


Fig. 28. Percentage of the Cattle Egrets associated during different months.

similar to that of Dinsmore (*op. cit.*) was conducted, results of which are given in Table 37. The present experiment also supports the above statement. However, following optimal foraging strategy, the egret will remain in highly beneficial foraging habitats, regardless of the presence or absence of cattle.

Table 37: Foraging efficiency of the Cattle Egret when associated and feeding alone (based on 2 min. paired observations)

	Associated (with Buffaloes)	Alone
Minutes observed	128	128
Strikes	544	320
Captures	496	224
Steps taken	2032	4096
Steps/Capture	4.09	18.28
Captures/minute	3.87	1 75
*Efficiency ratio	1.05	10.44

$$\text{* Efficiency ratio} = \frac{\text{Steps/capture}}{\text{Captures/minute.}}$$

There is ample documentation of the Cattle Egrets either removing or having in diet, ticks (Fitzsimmons 1923, Priest 1933, Bates 1937, Beven 1946, Holman 1946, Skead 1966, Siegfried 1966b, 1971d, Snoddy 1969, Mukherjee 1971, Fogarty and Hetrick 1973, Herrera 1974, McKilligan 1984), or/and irritating dipterans (Kadry-Bey 1942, Middlemiss 1955, Reid 1955, Ikeda 1956, Dawn 1959, De Jager 1959, Thistle 1959, Curry-Lindahl 1960, Kosugi 1960, Skead 1963, Blaker 1965, Jenni 1969, 1973, Snoddy 1969, Fogarty and Hetrick 1973, pres. obs.). The Cattle Egret detaches a tick from cattle by holding it in its bill and then vigorously shaking its head sideways (Skead 1966). The egret removes dipterans generally from the under-side of the cattle (pres. obs., Plate 30). Moreover, the egrets consume a considerable number of insects that compete with cattle for food e.g. grasshoppers (Siegfried 1971d, Kushlan 1978, pres. obs.). Thus, cattle are also benefited from this association. The association of cattle and the Cattle Egret is termed as commensalism or obligatory commensalism or mutualism or facultative mutualism or symbiosis. The most appropriate name for this association is, however, given by Siegfried (1978), viz. protocooperation. Hanson (1962) defined protocooperation as " interaction between organisms that is mutually beneficial but is not obligatory to those participating"

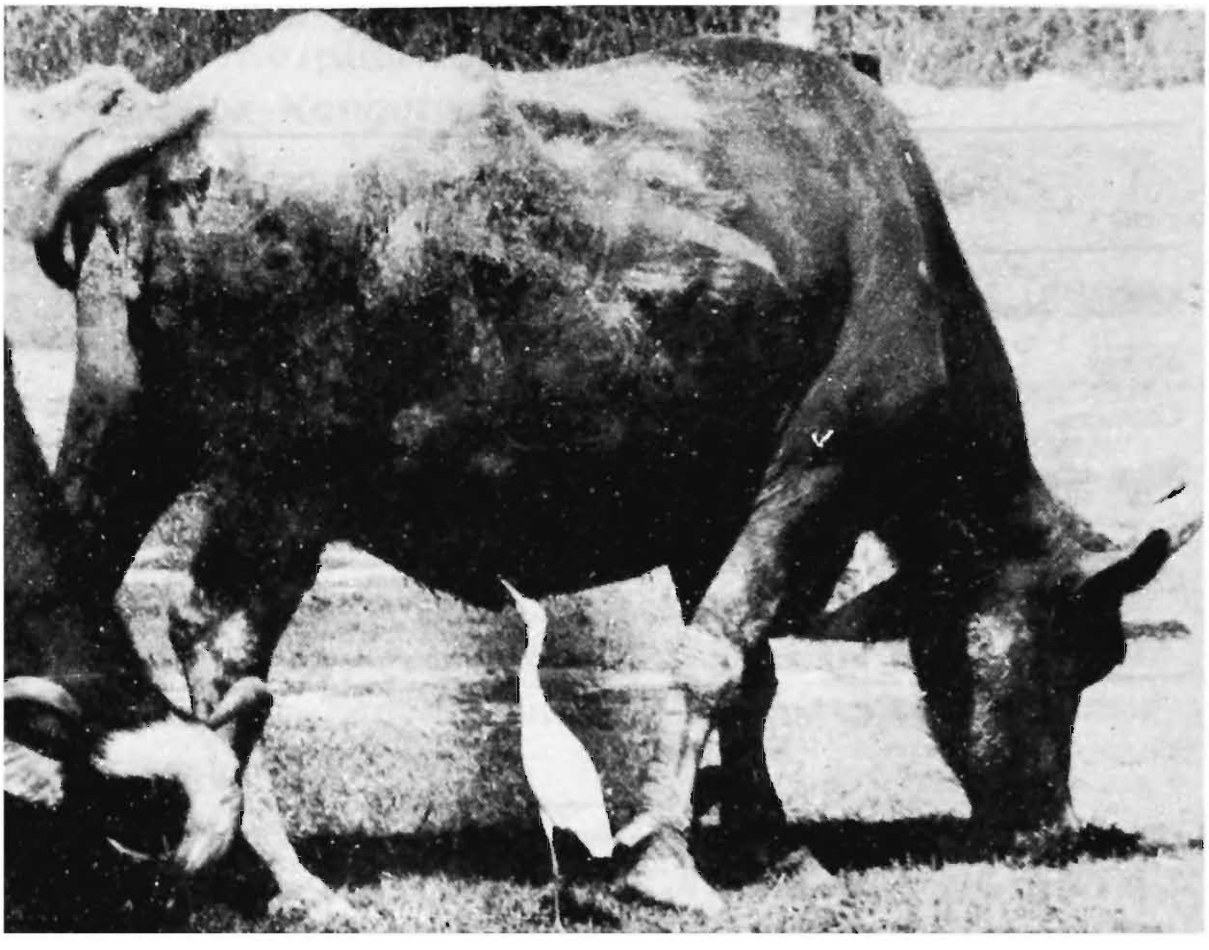


Plate 30. A Cattle Egret picking up diptrans from the underside of a buffalo.

A single egret is more benefited while foraging with cattle than two or more (Grubb 1976). Thus, as suggested by Thompson *et al.* (1982), egrets may regulate their number while following cattle. This regulation can be brought about by defending the cattle or by avoiding the cattle which already have the accompanying egrets. Most frequently (> 70%), the Cattle Egret feeds near the head of the cattle, because the region near the head yields more food than other regions of the body (Siegfried 1978). Sometimes, the Cattle Egrets gather and rest near the resting cattle. It is quite likely that the egrets synchronize their resting period with that of cattle. The egrets, at times, try to stir up the cattle by making restless flights near them (Dawn 1959).

Little is known about the behaviour of cattle in accordance with the egrets. Rarely, the cattle are hostile to the egrets (Hewitt 1961, pres. obs.), but in general they accept the presence of egrets with equanimity.

5.3 FOOD

The food analysis of 95 samples is given in Table 38 and Fig. 29. In all, 5049 food items were identified and weighed. A mean of 53.1 food items were present per stomach. From the table it is evident tht the Cattle Egret is predominantly an insect forager (92.1% of total by number). Out of insects, most frequent (77.8%) were orthopterans.

The length of food items varied from 3-215 mm., the mean being 10.5 mm. (of 4539 measured food items). Most frequently, the food items had length in between 3-19 mm. (Fig. 30).

Figs. 31 - 35 show relative abundance of main groups (Annelida, Odonata, Dermaptera,Coleoptera,Diptera, Lepidoptera and Arachnida) of food items during different seasons. From the figures it is evident that dipterans dominate the diet in winter and spring, and orthopterans during the rest of seasons i.e. summer, rainy season and autumn. Possibly, relative availability of these groups, in nature, during different seasons is the main reason for their abundance in diet. Annelids (mainly earthworms) were more frequent as a food item during rainy season and summer, in the months when they are more available. Dermapterans (earwigs) were more frequent during autumn, because, during this season, fields in this area are thoroughly ploughed for sowing of wheat and thus making these dermapterans vulnerable to the egrets. Arachnids were more frequent in diet in winter than in other seasons. Presumably, their availability was higher during winter.

Table 38: Analysis of the food of the Cattle Egret

Food Item	% Occurrence	% by number	% by weight
1	2	3	4
ANNELIDA			
? Adult	4.2	0.6	0.2
Megascolecidae			
Pheretima sp.	9.4	0.6	2.0
INSECTA			
Odonata			
Anisoptera			
Naiads	7.3	0.9	0.7
Libellulidae			
Crocothemus sp.	5.2	0.1	0.4
Trithemis sp.	2.1	+	0.1
Zygoptera			
Naiads	1.0	+	+
Coenagriidae			
Ischnura sp.	5.2	0.1	+
Orthoptera			
Acridiidae			
Ergatettix sp.	20.0	3.6	0.8
Chrotogonus sp.	23.1	2.2	4.7
Acridium sp.	41.0	2.5	4.0
Atractomorpha sp.	13.6	0.7	0.8
Oxya sp.	7.3	0.4	0.4
Gryllidae			
Pternemobius sp.	6.3	0.1	+
Gymnogryllus sp.	2.1	0.4	0.3
Tridactylus sp.	15.7	1.3	0.1
Gryllopsis sp.	1.0	0.1	+
Acheta sp.	25.2	1.6	2.9
Liogryllus sp.	1.0	+	0.3
Tetrigidae			
Locusta sp.	7.3	0.2	3.0

Contd.....

Food Item	% Occurrence	% by number	% by weight
1	2	3	4
Gryllotalpidae			
Gryllotalpa fossor	27.3	1.0	4.5
Dermaptera			
Labiduridae			
Anisolabis sp.	16.8	0.8	0.1
Labidura sp.	6.3	0.3	0.1
Dictyoptera			
Blattidae			
Periplenata sp.	1.0	+	+
Phyllodromia sp.	4.2	+	+
Mantidae			
Mantis religiosa	5.2	0.1	0.2
Isoptera			
Termes sp.	6.3	1.3	0.4
Hemiptera			
Nepidae			
Laccotrephes maculatus	1.0	+	+
Reduviidae			
Prostemma sp.	1.0	+	+
Polytoxus sp.	1.0	+	+
Pentatomidae			
Audinetia sp.	2.1	+	+
Membracidae			
Ceresa sp.	6.3	0.2	+
Coleoptera			
Scarabaeidae			
Larvae	7.3	0.9	+
Onthophagus sp.	12.6	0.6	0.1
Trox sp.	1.0	+	+
Anomala sp.	8.4	0.1	0.1

Contd.....

Food Item	% Occurrence	% by number	% by weight
1	2	3	4
Curculionidae			
Hypera variabilis	1.0	+	+
Hypera sp.	7.3	1.5	+
Tadius sp.	3.1	0.2	+
Tanymecus sp.	1.0	+	+
Carabidae			
Tachys sp.	11.5	1.7	0.2
Bembidion sp.	3.1	+	+
Calosoma sp.	12.6	0.4	0.2
Chloenius sp.	4.2	+	+
Trichisia sp.	1.0	+	+
Tetragonoderus sp.	2.1	+	+
Oxylobus sp.	5.2	+	+
Pheropsopus sp.	1.0	+	+
Tenebroidae			
Gonocephalum sp.	7.3	0.4	0.3
Tribolium sp.	2.1	+	+
Pseudoblaps sp.	2.1	+	+
Opatroides sp.	1.0	+	+
Histeridae			
pachylister sp.	2.1	+	+
Hololepta sp.	1.0	+	+
Haliplidae			
Haliplus sp.	2.1	+	+
Hydrophilidae			
Larvae	1.0	+	+
Trogositidae			
Tenebroides sp.	1.0	+	+
Diptera			
Cordyluridae			
Scatophaga stercoraria	12.6	10.2	2.8

Contd.....

Food Item	% Occurrence	% by number	% by weight
1	2	3	4
Calliphoridae			
Rhinia sp.	2.1	+	+
Lucilia sp.	3.1	0.2	+
Strongyloneura sp.	6.3	0.1	+
Cosmina sp.	1.0	+	+
Muscidae			
Gymnodia sp.	5.2	0.2	+
Musca domestica	2.1	0.2	+
Musca sp.	12.6	0.4	+
Pycnosoma sp.	1.0	+	+
Mydea sp.	1.0	+	+
Syrphidae			
Larvae	1.0	+	+
Eristalis tenax	4.2	0.1	+
E. taphicus	2.1	+	+
E. obscuritarsis	2.1	1.0	0.6
Syrphus aeneifrons	7.3	0.2	+
S. corolle	1.0	+	+
Lasiopticus seleniticus	1.0	+	+
Melanostoma orientale	8.4	0.3	+
Episyrphus balteatus	10.5	0.4	+
Sphaerophoria indiana	9.4	0.7	+
Ischiodon scutellaris	2.1	+	+
Simuliidae			
Simulium sp.	14.7	31.2	2.7
Sarcophagidae			
Sarcophaga sp.	21.0	4.6	1.3

Contd.....

Food Item	% Occurrence	% by number	% by weight
1	2	3	4
Conopidae			
Conops sp.	2.1	+	+
Tipulidae			
Tipula sp.	5.2	0.1	+
Dolichopidae			
Psilopus sp.	4.2	0.1	+
Agromyzidae			
Balioptera sp.	1.0	+	+
Otitidae			
Physiphora demandata	2.1	0.3	+
Bombyliidae			
Argyramoeba sp.	1.0	+	+
Tachinidae			
Bombyliomyia sp.	14.7	0.4	0.2
Asilidae			
Philonicus sp.	2.1	+	+
Promachus sp.	4.2	+	+
Laxenecera sp.	1.0	+	+
Tabanidae			
? Adult	1.0	+	+
Tabanus sp.	1.0	+	+
Lepidoptera			
Caterpillars	40.0	10.8	14.7
Noctuidae			
Leucania sp.	12.6	0.4	+
Pieridae			
Pieris candia	1.0	+	+
Hymenoptera			
Formicidae			
Pheidole sp.	9.4	0.4	+

Contd.....

Food Item	% Occurrence	% by number	% by weight
1	2	3	4
Tenthredinidae			
Athalia proxima	2.1	+	+
Pupae	1.0	+	+
Oothecae	2.1	+	+
ARACHNIDA			
Lycosidae			
Pardosa sp.	15.7	3.1	0.7
Lycosa sp.	42.1	2.8	0.9
Hippasa sp.	2.1	0.2	0.1
Linyphidae			
Drapetisca sp.	2.1	+	+
Salticidae			
Salticus sp.	1.0	+	+
Esparassidae			
Palyster sp.	1.0	+	+
Argiopidae			
? Adult	4.2	0.1	+
Thomisidae			
Dieta sp.	1.0	+	+
MYRIAPODA			
Chilopoda			
Centipede	4.2	+	0.2
AMPHIBIA			
? Adult	2.1	+	0.7
Ranidae			
Rana sp.	7.3	0.1	10.1
Bufonidae			
Bufo sp.	17.8	0.5	25.7
REPTILIA			
Scincidae			
Leiolopisma sp.	9.4	0.2	3.7

Contd.....

Food Item	% Occurrence	% by number	% by weight
1	2	3	4
Iguanidae			
Streptosaurus sp.	1.0	+	0.8
Agamidae			
Calotes sp.	2.1	+	1.7
Eumeces sp.	1.0	+	0.1
MAMMALIA			
Shrew	1.0	+	0.3
Rat	2.1	+	1.0

+, values less than 0.1%

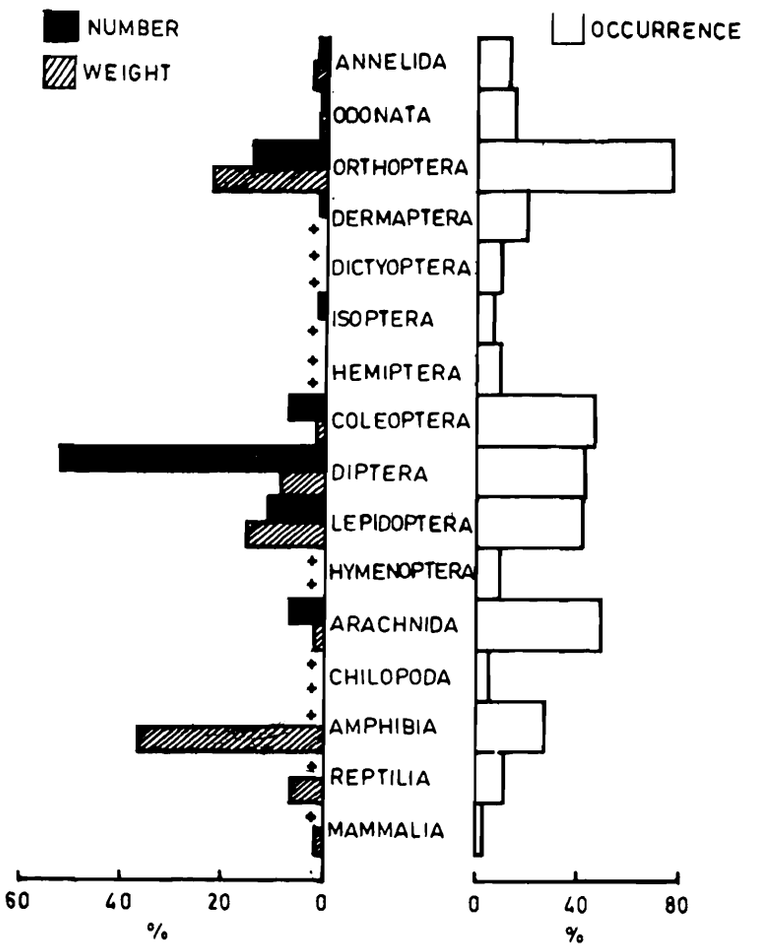


Fig. 29. Diagrammatic representation of the analysis of the diet of the Cattle Egret. Sign + refers to values less than 1.0%.

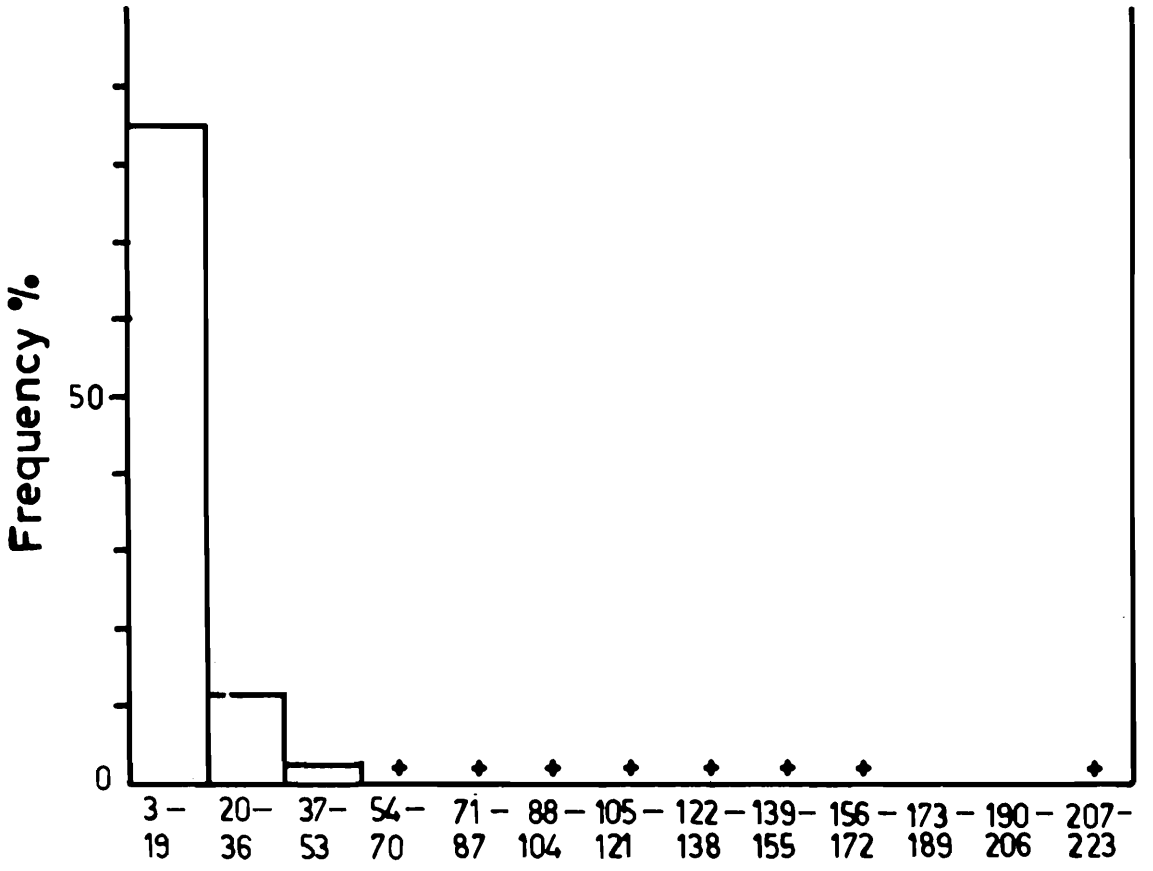
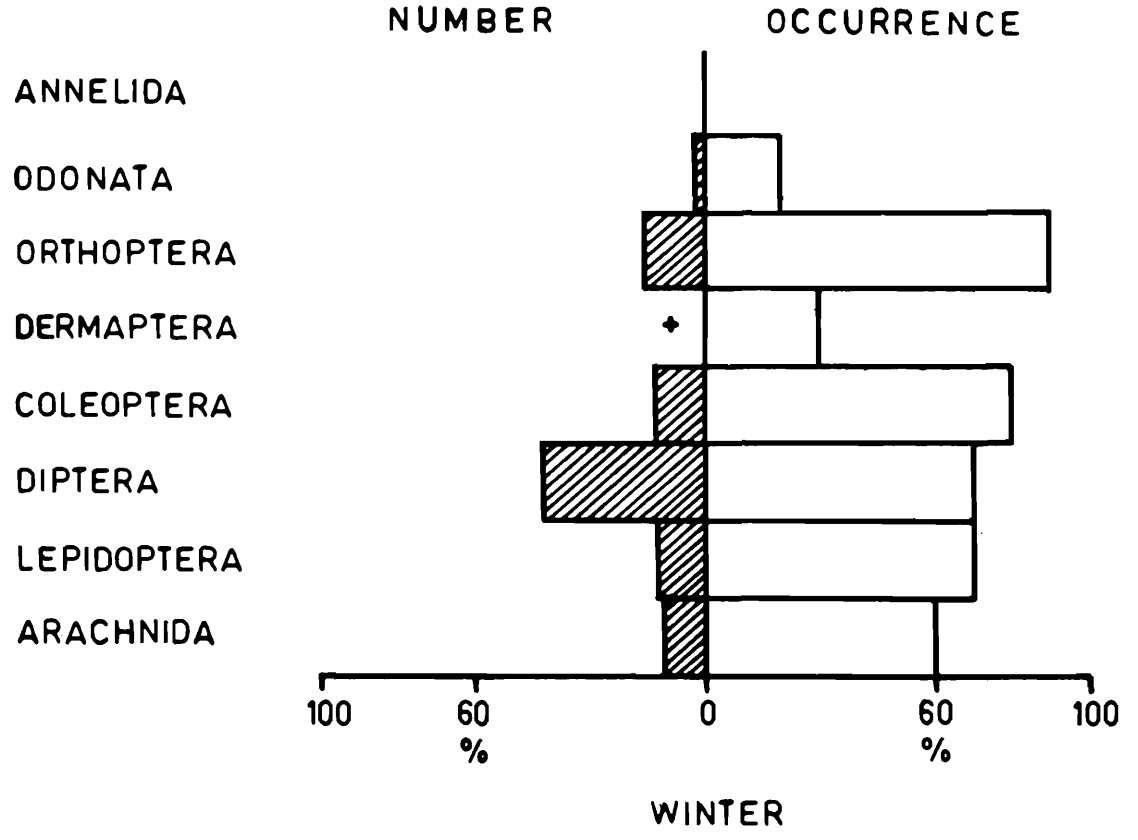
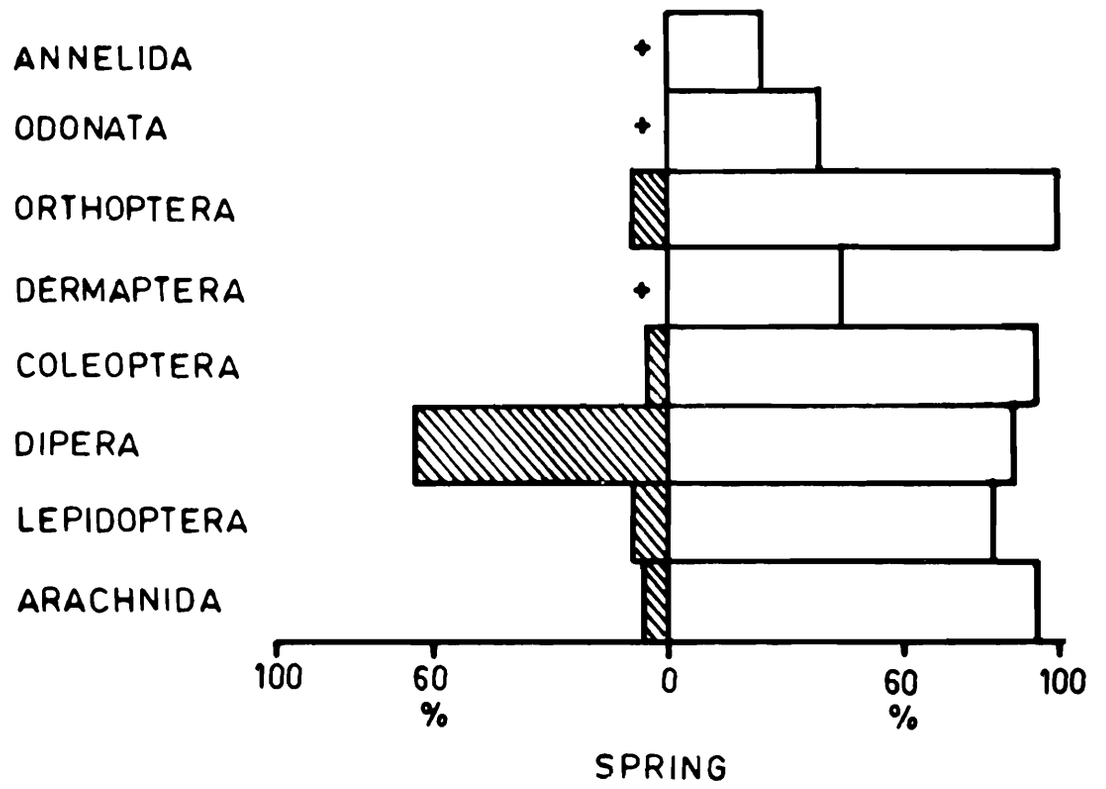
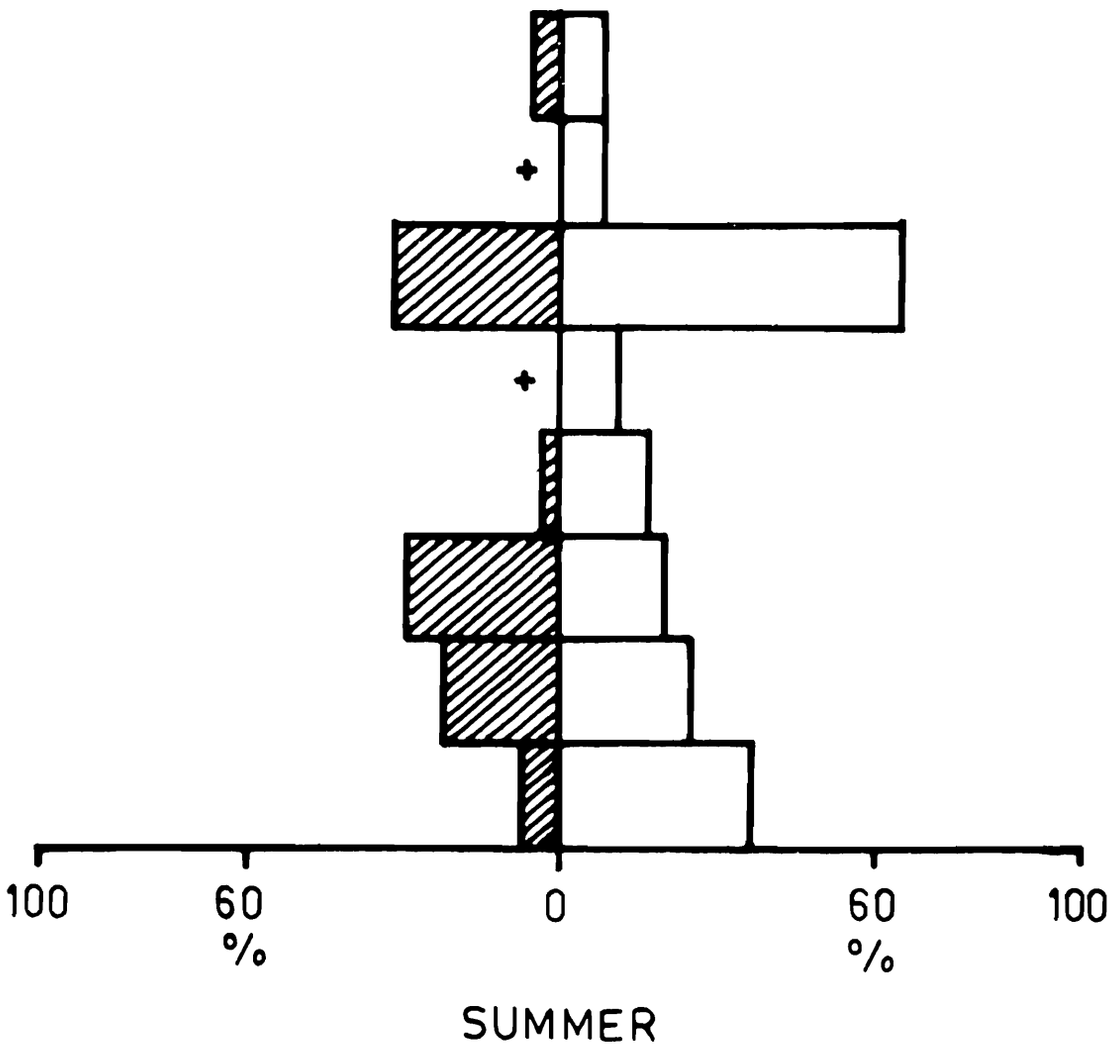


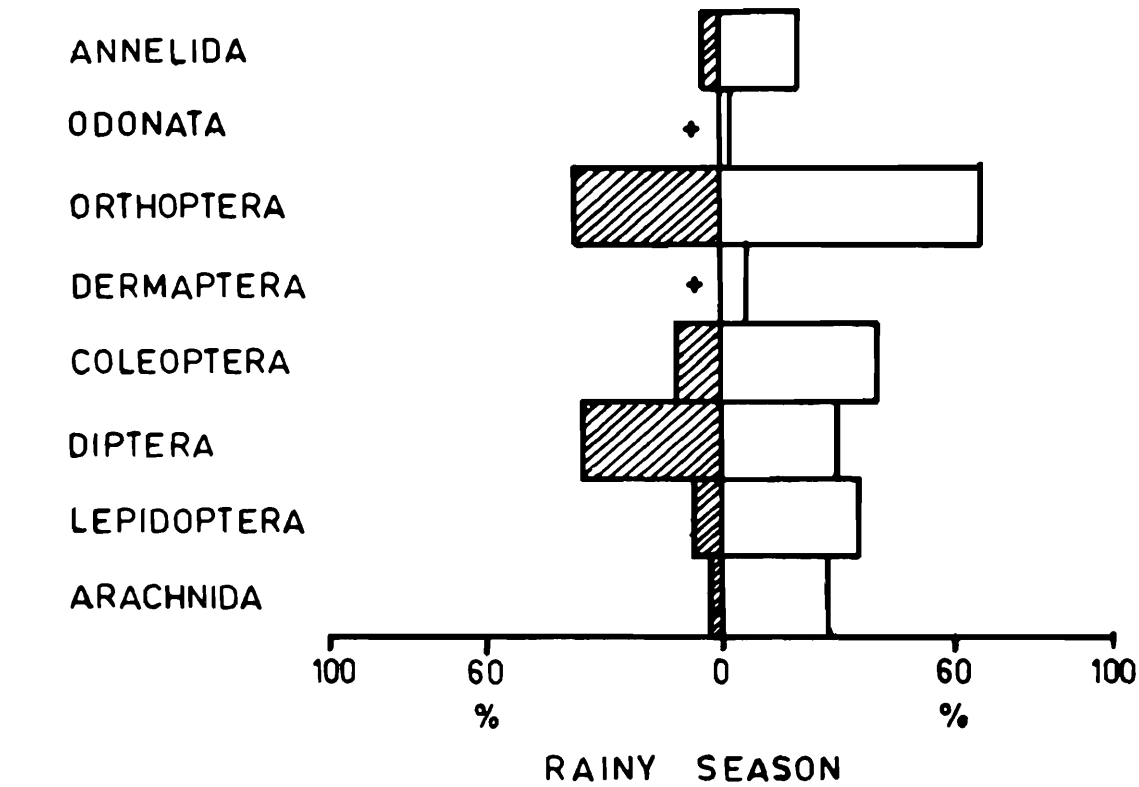
Fig. 30. Frequency distribution of the length of the food items. Sign + refers to values less than 1.0%.

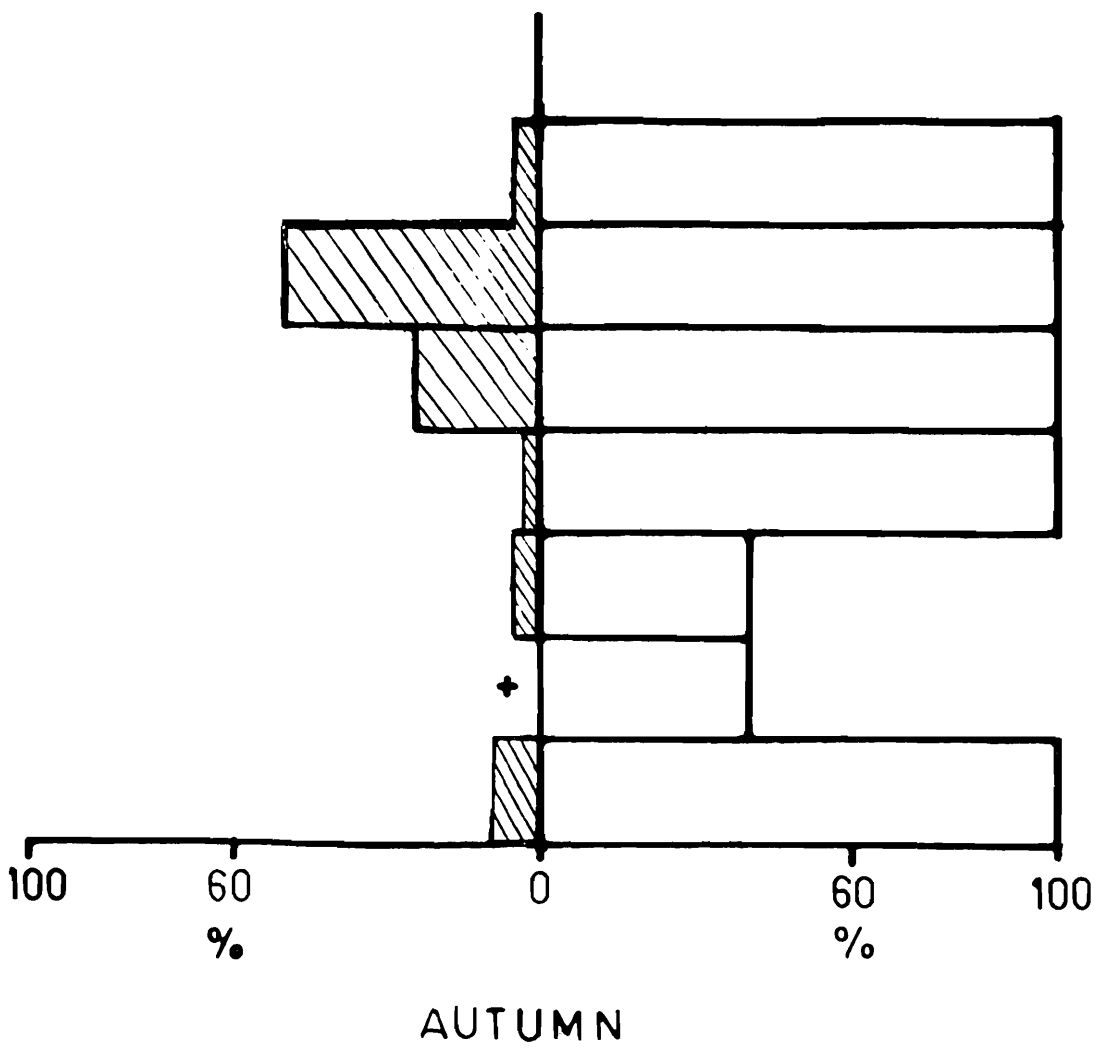


Figs. 31-35. Relative abundance of different groups in food during different seasons. Sign + refers to values less than 1.0%.


ANNELIDA
ODONATA
ORTHOPTERA
DERMAPTERA
COLEOPTERA
DIPERA
LEPIDOPTERA
ARACHNIDA
100
60
%
0
60
%
100
SPRING


100
60
%
0
60
%
100
SUMMER


ANNELIDA
ODONATA
ORTHOPTERA
DERMAPTERA
COLEOPTERA
DIPTERA
LEPIDOPTERA
ARACHNIDA
100
60
%
0
60
%
100
RAINY SEASON


100
60
%
0
60
%
100
AUTUMN

Like other groups, vertebrates also varied seasonally. Except for one shrew present in the sample collected in March, in all other seasons, except summer and rainy season, they were virtually absent. Reptilians and amphibians were present, in diet, during summer and rainy season. Reptilians were more abundant in diet during summer and amphibians during the rainy season.

Thus, main factor in seasonal variation in diet seems to be availability of a particular food item in nature. Such a statement is given by many authors (e.g. Owen 1955, Fasola *et al.* 1981).

Fig. 36 shows relationship between mean length of food items, and mean number of food objects and items consumed during different seasons. The term food item, as used here, refers to a particular food item e.g. *Pheretima* sp. or caterpillar whereas food objects refers to total of all food items. The figure reveals that there is a direct relationship between mean length of food items and mean number of food objects and items consumed. In other words, it can be concluded from figure that if the Cattle Egret consumes smaller food items, it consumes more and diverse food and vice-versa.

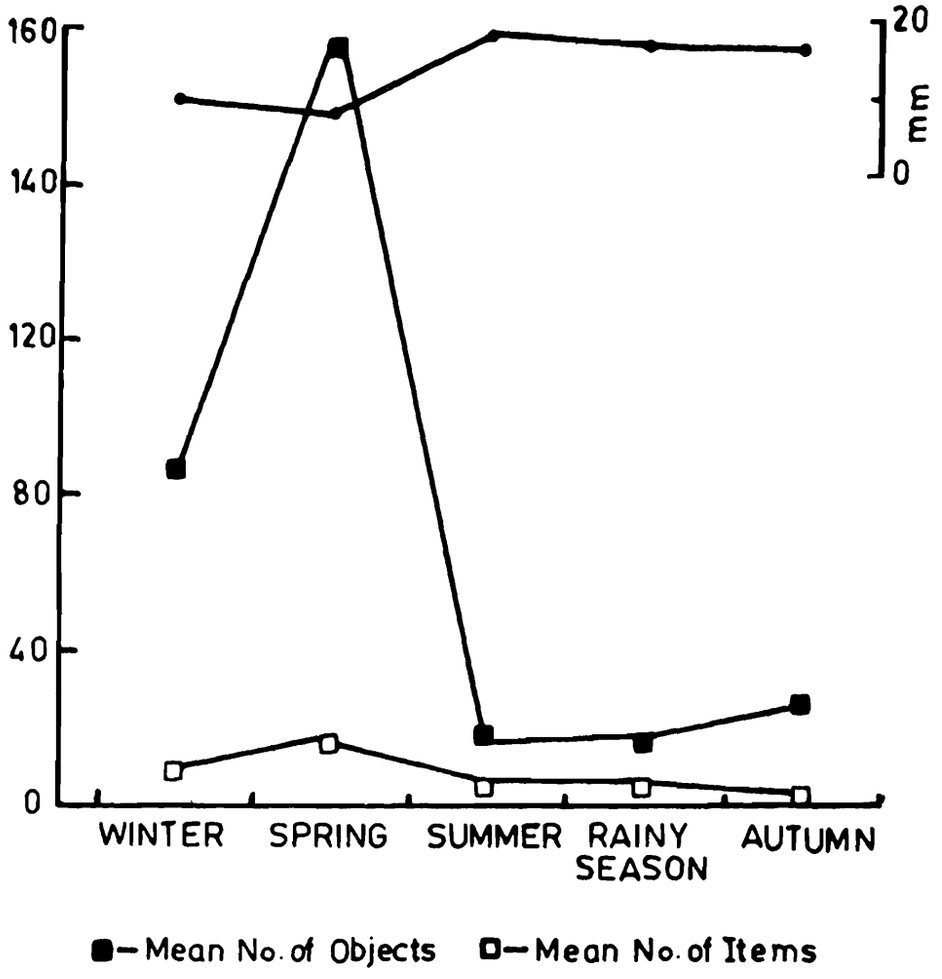


Fig. 36. Relationship between mean no. of objects, mean no. of items and mean langth of the food items consumed during different seasons.

Considerable individual diversity in the diet of birds shot together was noticed. For example, six birds shot together had major food groups in following proportions. These birds foraged in the same habitat for at least one hour and had equal foraging opportunities:

Bird A : caterpillars - 2.4%; grasshoppers - 19.9%; dipterans - 22.3%; spiders - 6.9%.

Bird B caterpillars - 2.2%; grasshoppers - 3.1%; dipterans - 93.1%; spiders - 0%.

Bird C caterpillars - 25.0%; grasshoppers - 35.8%; dipterans - 8.3%; spiders - 10.8%.

Bird D : caterpillars - 0.3%; grasshoppers - 8.8%; dipterans - 82.7%; spiders - 4.6%.

Bird E : caterpillars - 11.8%; grasshoppers - 8.6%; dipterans - 57.2%; spiders - 4.2%.

Bird F : caterpillars - 0%; grasshoppers - 83.3%; dipterans - 0%; spiders - 0%.

Siegfried (1971d) also noted similar individual diversity in the diet of the Cattle Egret in South Africa. He (*op. cit.*) had two speculations to offer for this diversity, viz. concentrated availability of a particular food resource or foraging specialization of individual bird.

To examine the regional variation in food, data of present study, in terms of percentage of number of food items, are compared with those of Kadry-Bey (1942), Ikeda (1956), Siegfried (1966b), Mukherjee (1971), Jenni (1973), Herrera (1974), and McKilligan (1984), in Table 39. Few studies, e.g. Siegfried (1971d), expressed their data in terms of percentage of occurrence of food items, were thus not compared. The table reveals considerable regional variation in the diet of the Cattle Egret. However, this dietary variation in different regions is due to different faunal distribution rather than different feeding perference.

It can be concluded, that on the whole there is a great diversity in the diet of the Cattle Egret which suggests a wide degree of adaptability, a cardinal factor in species success.

Table 39: Comparison of the diet of the Cattle Egret with earlier studies. Prey expressed in percentage of number

	Present study	Egypt (Kadry-Bay 1942)	Japan (Ikeda 1956)	South Africa (Siegfried 1966)	Sundarban (India) (Mukherjee 1971)	North America (Jenni 1973)	Spain (Herrera 1974)	Australia (McKilligan 1984)
Annelida	1.34	—	—	—	+	—	—	—
Odonata	1.28	0.38	8.92	0.77	3.44	0.34	0.20	0.12
Orthoptera	14.77	50.77	1.95	77.55	29.76	84.42	79.70	68.9
Dermaptera	1.22	2.58	0.02	—	0.98	0.03	0.27	0.01
Dictyoptera	0.23	0.27	—	0.51	1.19	—	6.35	1.04
Isoptera	1.32	—	—	—	—	0.05	—	—
Neuroptera	—	0.01	—	0.08	—	—	—	—
Hemiptera	0.41	0.15	0.18	0.08	14.36	0.01	0.13	17.69
Coleoptera	7.09	11.50	42.8	2.59	14.19	0.70	2.16	0.22
Psocoptera	—	—	—	0.08	—	—	—	—
Diptera	52.18	2.69	17.52	2.59	0.61	1.25	1.42	0.84
Lepidoptera	11.36	19.78	1.82	3.72	5.66	0.26	3.04	0.63

Contd.....

	Present study	Egype (Kadry-Bay 1942)	Japan (Ikeda 1956)	South Africa (Siegfried 1966)	Sundarban (India) (Mukherjee 1971)	North America (Jenni 1973)	Spain (Herrera 1974)	Australia (McKilligan 1984)
Hymenoptera	0.49	0.13	—	0.43	4.70	0.03	0.20	0.02
Phasmida	—	—	—	0.08	0.20	0.01	—	0.02
Arachnida	6.81	4.24	26.17	9.79	22.86	5.97	1.89	6.71
Myriapoda	0.07	0.09	—	—	—	—	0.60	0.03
Crustacea	—	3.51	0.08	—	—	—	0.33	0.03
Amphibia	0.71	2.97	0.26	1.29	1.97	6.73	0.60	2.18
Pisces	—	0.12	—	—	—	—	0.06	—
Reptilia	0.39	0.03	—	—	—	0.13	2.30	1.44
Aves	—	+	—	0.34	—	—	—	—
Mammalia	0.05	0.18	—	—	—	—	0.06	0.03

6. POPULATION

6.1 POPULATION IN CHANDIGARH (U.T.)

Union Territory Chandigarh is situated 30°40′ N to 30°48′ N and 76°42′ E to 76°51′ E near the foot hills of Shivaliks. It comprises a centrally placed city of Chandigarh, surrounding villages and Mani Majra town. Rural sector is spread over an area of 56. 4 sq. kms., while the urban component which comprises two units, viz. Chandigarh city and Mani Majra town, covers an area of 57.6 sq. kms.

6. 11 REPORT OF CENSUSES

Results of the census of heronries taken during 1983 and 1984 are given in Table 40. During 1983 there were six heronries in the Union Territory Chandigarh which harboured 397 nests of *Bubulcus ibis coromandus* during the peak breeding season. No heronry was situated in the urban sector of Union Territory; all the heronries were located in the villages (Figs. 37 and 38), as only the villages carry cultivated land.

During 1983, as there were 397 breeding pairs i.e., 794 breeding *B.i. coromandus,* the breeding population density of this species was 6.96 egrets per sq. km. of the entire territory. During 1984 three heronries were deserted due to human disturbance leaving only three heronries in the Union Territory. These three heronries harboured 329 breeding pairs or 658 breeding *B.i. coromandus* during 1984. The breeding population density of this species decreased to 5.77 egrets per sq. km.

During 1983 all the heronries in Union Territory were exclusively constituted by the *Acacia arabica* trees resulting in Homogeneous heronries. In 1984, two heronries, viz. Maloya and Burail, which were previously Homogeneous heronries, turned into Heterogeneous. During 1984 out of the 329 nests, 303 (92.0%) nests were on *A. arabica* whereas 15 (4.5%) nests were on *Dalbergia sissoo,* 8 (2.4%) nests were on *Prosopis spicigera* and 3 (0.9%) nests were on *Melia azadirachta.*

No winter-roost of *B.i. coromandus* was located in this area during 1983 and 1984. Subsequent observations showed that this was due to seasonal migration. This migration of *B.i. coromandus* from the Union Territory Chandigarh seems to be the result of scarcity of food in the Union Territory in winter months.

Table 40: Results of the Censuses of heronries in Union Territory Chandigarh during 1983 and 1984

Sr. No.	Name of heronry	1983				1984			
		Type of heronry	No. of section	No. of trees	No. of nests counted	Type of heronry	No. of section	No. of trees	No. of nests counted
1	Khuda Lahora	ACTHoP	1	3	28	Deserted	—	—	—
2	Dhanas	ACTHoP	1	1	46	Deserted	—	—	—
3	Dadu Majra	ALTHoP	2	3	59	Deserted	—	—	—
4	Maloya	ALTHoP	2	4	96	ALTHoP	2	7	140
5	Burail	ALTHoP	2	5	42	ALTHoP	2	4	38
6	Bhagwanpur	ALTHoP	4	6	126	ALTHoP	5	7	151
	Total				397				329

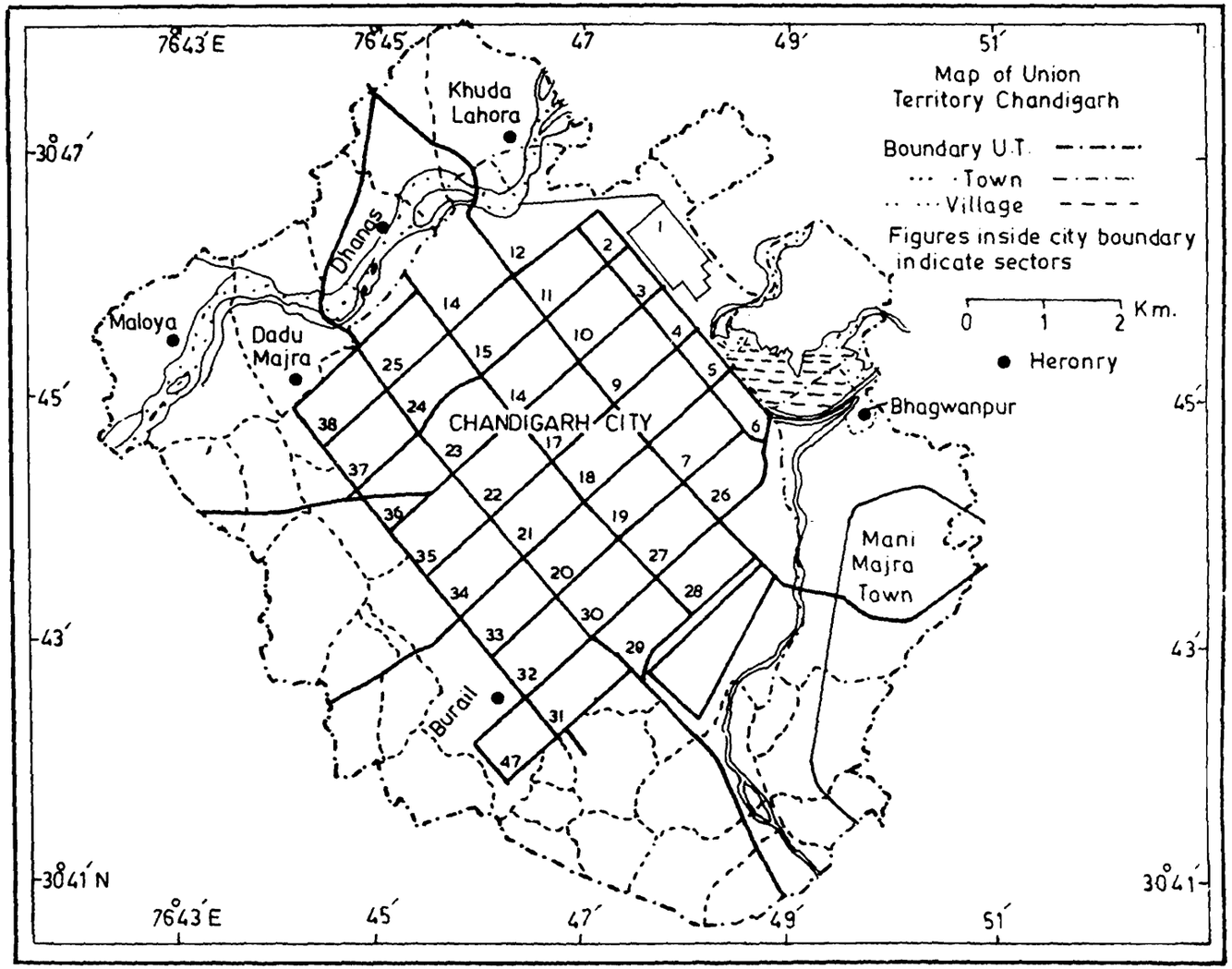


Fig. 37. Location of heronries in the Union Territory Chandigarh during 1983.

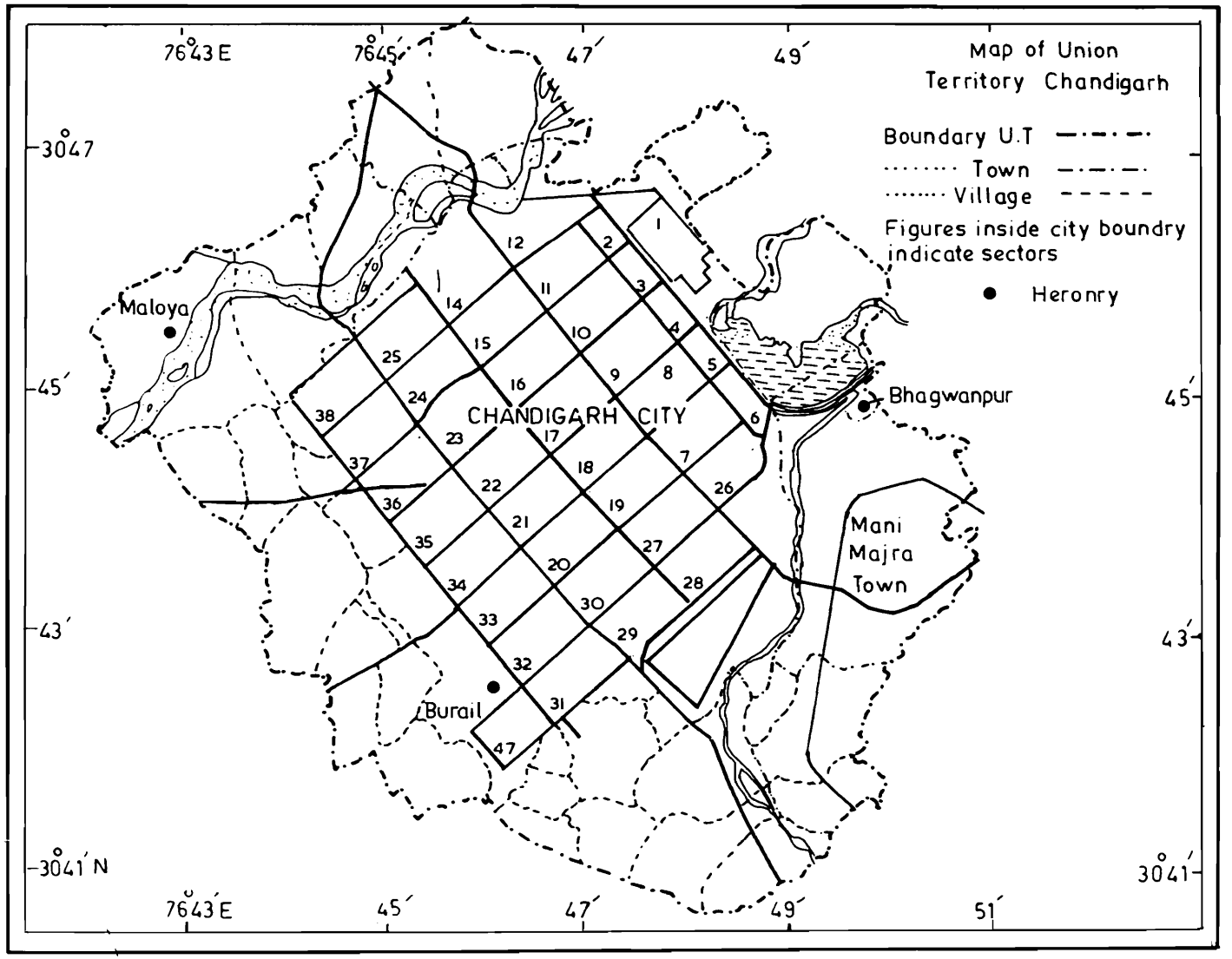


Fig. 38. Location of heronries in the Union Territory Chandigarh during 1984.

6.2 POPULATION IN THE PUNJAB STATE

On the basis of topography, climate, soils and water resources, the state of Punjab is broadly divided into three zones, viz. Submontane zone, Central Plains and Southern dry zone (Fig. 39). The Submontane zone covers an area of 0.46 million hectares and includes foot-hills of Shivalik ranges, parts of Hoshiarpur, Gurdaspur, Rupnagar and Patiala districts. Undulating topography and Chos or Raos (small seasonal rivers) are the main characteristics of this zone. The central Plains cover an area of 3.16 million hectares including Amritsar, Kapurthala, Jullundar, Ludhiana and parts of Gurdaspur, Hoshiarpur, Patiala and Sangrur district. Flat topography is the main characteristic of this zone. Southern dry zone comprises an area of 1.41 million hectares and includes the districts of Ferozepur, Bathinda and parts of districts Sangrur, Faridkot and Patiala. The main characteristics of this zone are the sand-dunes. About 0.3 million hectares of land is estimated to be under the sand-dunes.

For the study of population density of *Bubulcus ibis coromandus* in Punjab, four quadrats of 10 × 10 sq. kms. were selected, one in Submontane zone (in Rupnagar district, quadrat-1), one in Central plains (in Patiala district, quadrat-2), one in the intermediate parts of Central Plains and Southern dry zone (in Sangrur district, quadrat-3) and one in Southern dry zone (in Bathinda district, quadrat-4).

Breeding bird census or census of heronries and Christmas counts were made in the years 1983 and 1984 to assess the breeding and winter population densities of *B.i. coromandus* in the quadrats. Account of the censuses in these quadrats is as under:

6.21 QUADRAT-1

This quadrat is located 30°44′ N to 30°51′ N and 76°35′ E to 76°45′ E. Main Kharif crops (June-August to September-December) in this quadrat are maize and paddy. Maize is grown in approximately 55% of the total cultivated land while in approximately 25% of the total cultivated land, paddy is grown. Wheat and sugarcane are the main Rabi crops (October-November to March-April).

6.211 *Report of censuses*

During 1983, fourteen heronries of *B.i. coromandus* were located in quadrat-1 (Fig. 40). These fourteen heronries contained 917 nests in the peak breeding season (Table 41) i.e. 917 breeding pairs or 1834 breeding *B.i. coromandus*. The breeding population density of *B.i. coromandus* in quadrat-1 was thus 18.34 egrets per sq. km.

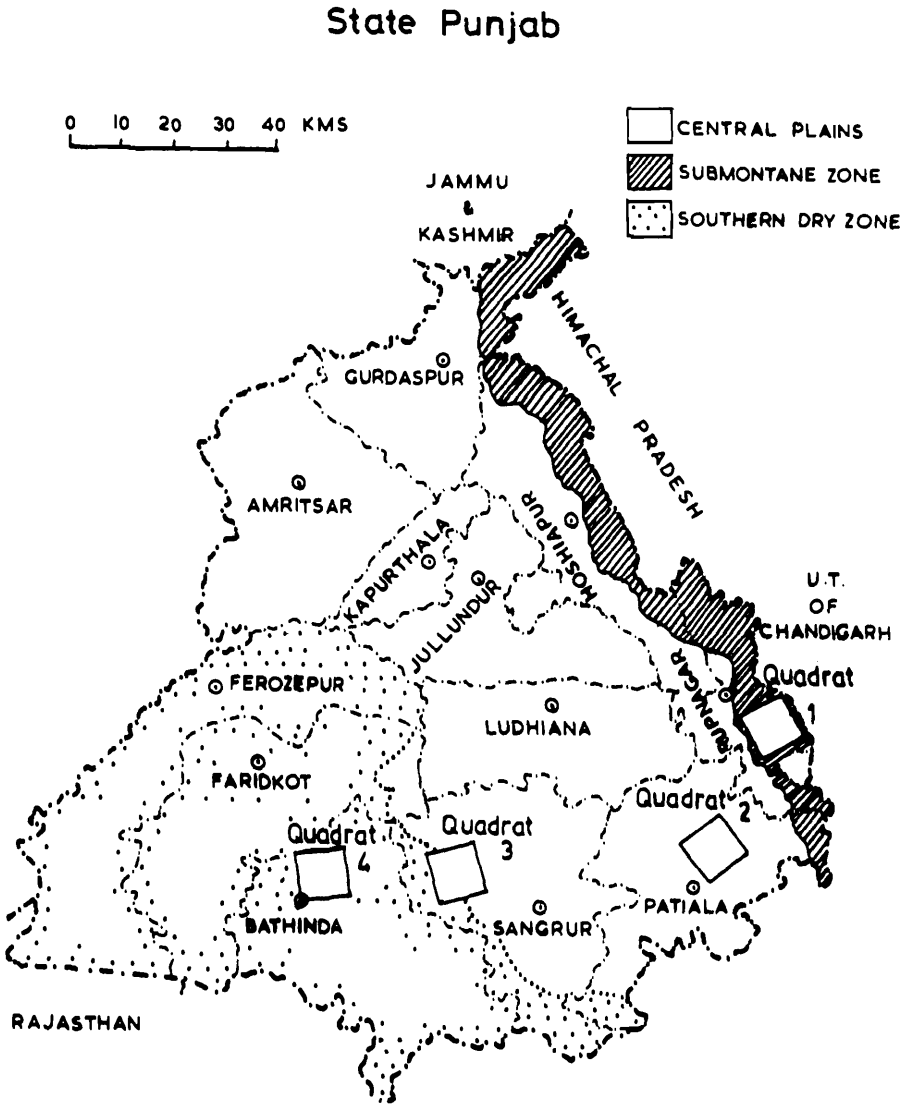


Fig. 39. Location of quadrats in the state Punjab.

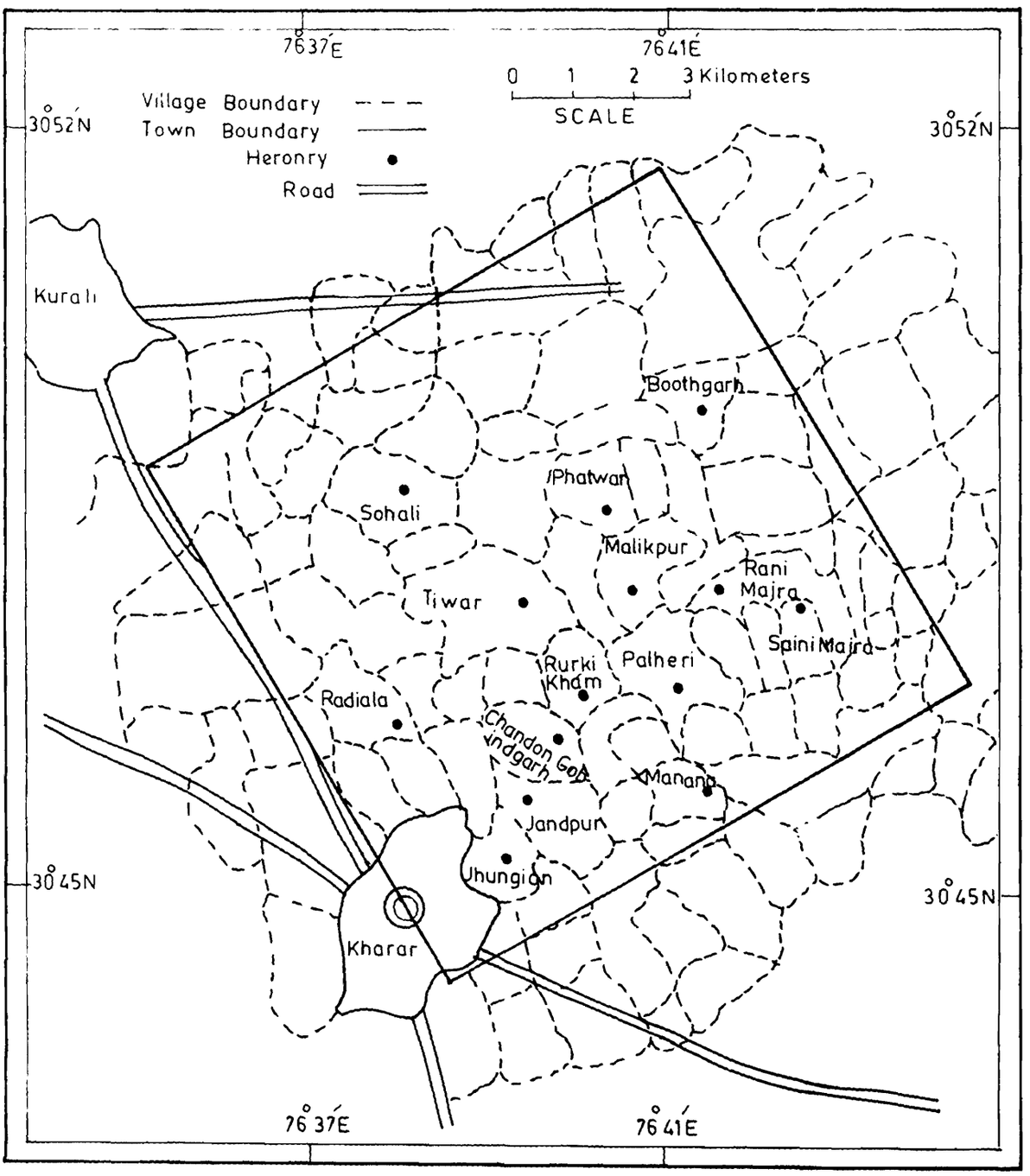


Fig. 40. Location of heronries in quadrat-1 during 1983.

Table 41: Results of the censuses of heronries in quadrat - 1 during 1983 and 1984

Sr. No.	Name of heronry	1983 Type of heronry	1983 No. of section	1983 No. of trees	1983 No. of nests counted	1984 Type of heronry	1984 No. of section	1984 No. of trees	1984 No. of nests counted
1	Manana	ALTHoP	4	7	105	ALTHoP	4	7	106
2	Jandpur	ACTHoP	1	2	59	ACTHoP	1	2	92
3	Jhungian	ACTHoP	1	1	45	Deserted	—	—	—
4	Chandon Gobindgarh	ALTHoP	2	3	79	ACTHoP	1	2	87
5	Saini Majra	ACTHoP	1	1	10	Deserted	—	—	—
6	Malikpur	ACTHoP	1	3	30	ACTHoP	1	1	15
7	Rani Majra	ALTHoP	4	12	134	ALTHoP	3	5	63
8	Phatwan	ALTHoP	3	8	72	ALTHoP	4	9	166
9	Sohali	ALTInP	2	6	55	ALTHoP	3	6	174
10	Tiwar	ALTHoP	2	2	45	Deserted	—	—	—
11	Radiala	ACTHoP	1	1	25	ACTHoP	1	1	49
12	Boothgarh	ACTHoP	3	6	142	ALTHoP	4	8	201
13	Palheri	ALTHoP	3	6	46	ALTInP	7	12	120
14	Rurki Kham	ALTHoP	3	5	70	Deserted	—	—	—
	Total		31	63	917		29	53	1073

All the heronries were Homogeneous heronries except Sohali heronry which was an Intermediate heronry. Tree preference in this quadrat was very conspicuous, 915 (99.7%) nests were harboured by *Acacia arabica* trees while only 2 (0.21%) nests were on *Melia azadirachta* trees.

During December, 1983 when Christmas counting was made, only one winter roost was found in quadrat-1, located at Radiala village (Fig. 41). This winter-roost was constituted by thirteen trees of *Melia azadirachta* and was on the bank of a village pond. In this winter roost, 89 Cattle Egrets roosted alongwith two little Egrets. Therefore, the winter population density of *B.i. coromandus* in this quadrat was 0.89 egrets per sq. km. There was thus a clear decrease in population.

During 1984, four heronries were deserted out of previously existing fourteen (Fig. 42). Total breeding pairs during 1984 were 1073 i.e., 2146 breeding *B.i. coromandus*. Breeding population density during 1984 thus increased from 18.34 egrets per sq. km. in 1983 to 21.46 egrets per sq. km.

During 1984 out of ten heronries in the quadrat, one heronry of Palheri was Intermediate heronry. Out of 1073 nest, 1071 (99.8%) nests were on *Acacia arabica* Trees while only 2 (0.18%) nests were located on *Melia azadirachta*.

During 1984 no winter roost was present in this quadrat. Previously existing roost at Radiala was deserted and no new roost was found. Winter population of *B.i. coromandus* during 1984 was thus nil in quadrat-1 This suggests the trend towards seasonal migration in 1984 from the seasonal fluctuation of numbers in 1983 in quadrat-1.

6.22 QUADRAT -2

This quadrat is located 30°15′ N to 30°22′ N and 76°21′ E to 76°31′ E. Main Kharif Crop in this quadrat is paddy, grown in approximately 85% of the total cultivated land, while wheat dominates as Rabi crop.

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During 1983 quadrat-2 had 21 heronries which carried 979 nests (Table 42; Fig. 43). Therefore, 1958 breeding *B.i. coromandus* were there in quadrat-2. Thus the breeding population density in quadrat-2 was 19.58 egrets per sq. km. All the heronries in this quadrat were Homogeneous i.e. all nests during this period were harboured by *A. arabica* trees.

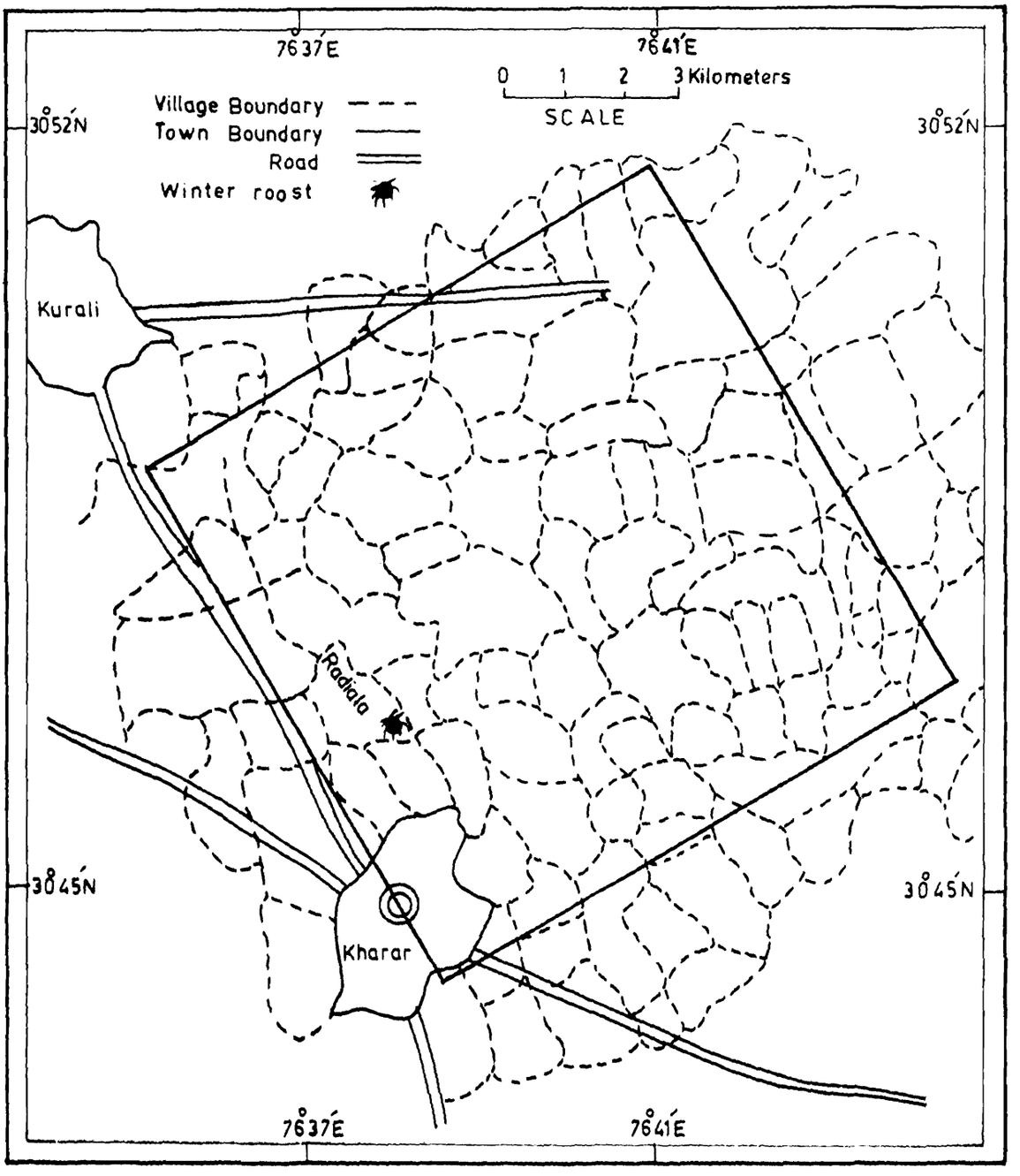

Fig. 41. Location of winter roost in quadrat-1 during 1983.

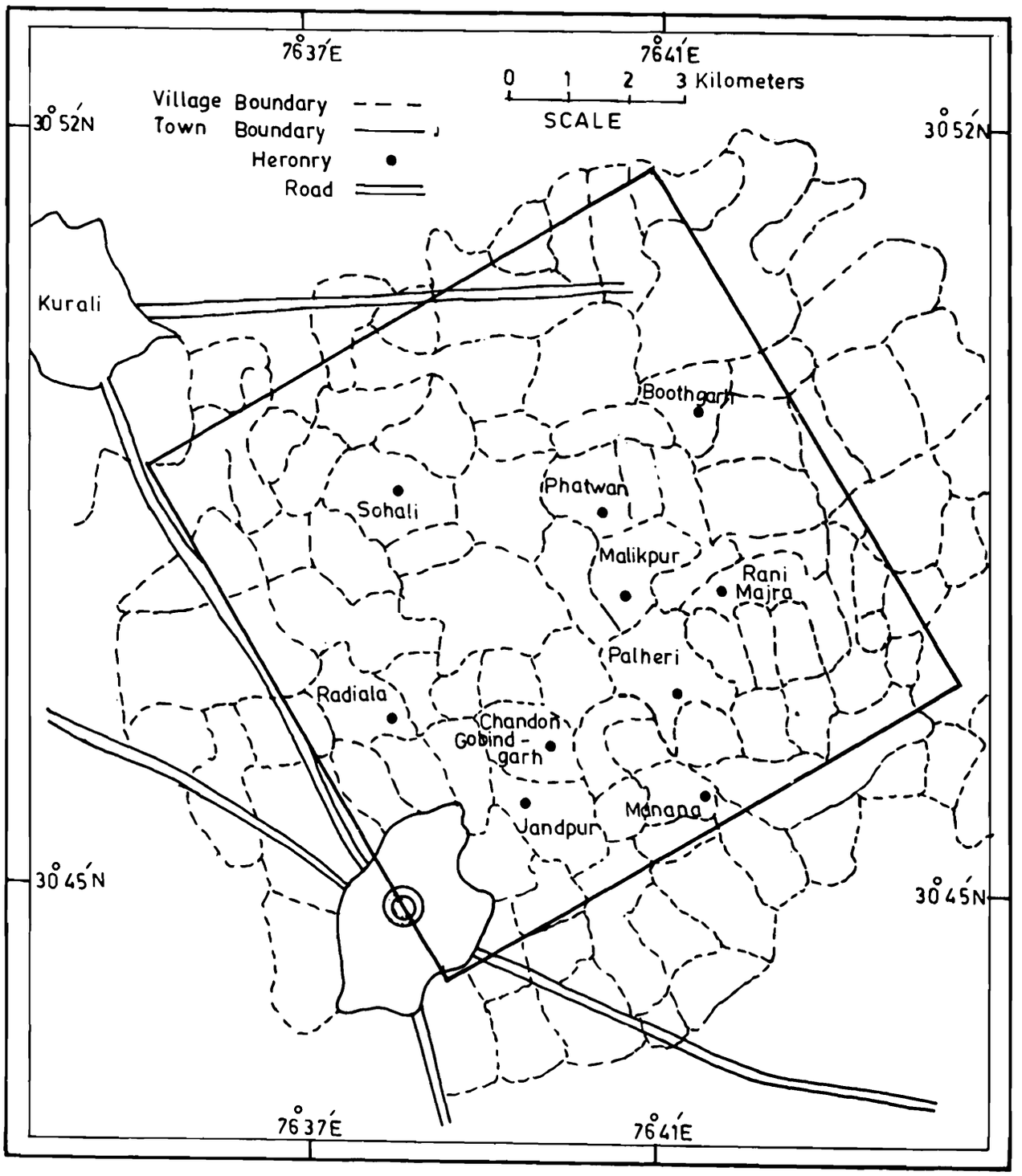

Fig. 42. Location of heronries in quadrat-2 during 1984

Table 42: Results of the censuses of heronries in quadrat - 2 during 1983-84

Sr. No.	Name of heronry	1983				1984			
		Type of heronry	No. of section	No. of trees	No. of nests counted	Type of heronry	No. of section	No. of trees	No. of nests counted
1	Kartarpura	ALTHoM	2	5	29	ALTHoM	2	4	35
2	Asarpur	ALTHoM	3	6	113	ALTHoM	4	8	150
3	Jogipur	ALTHoP	2	3	26	ALTHoP	2	3	30
4	Noor Kherian	ALTHoM	2	3	46	ALTHoM	2	3	53
5	Jalapur	ACTHoM	1	1	20	ALTHoM	2	3	62
6	Majri	ACTHoM	1	2	25	ALTHoM	2	4	61
7	Shamashpur	ALTHoM	3	5	65	ACTHoM	1	2	20
8	Kasba	ALTHoP	2	5	42	ALTHoP	2	3	48
9	Bhathlan	ACTHoP	1	2	23	ACTHoP	1	2	37
10	Raipur	ALTHoM	5	14	106	ALTHoM	3	5	139
11	Ajrawar	ACTHoP	1	1	29	ACTHoP	1	1	55
12	Pandtan	ALTHoP	2	4	26	ALTHoP	2	3	34
13	Chamarheri	ACTHoP	1	2	35	ACTHoP	1	2	42
14	Lakho Majra	ALTHoP	2	14	121	ALTHoP	4	15	162

Contd.....

Sr. No.	Name of heronry	1983 Type of heronry	1983 No. of section	1983 No. of trees	1983 No. of nests counted	1984 Type of heronry	1984 No. of section	1984 No. of trees	1984 No. of nests counted
15	Muradpur	ACTHoP	1	1	11	ACTHoP	1	1	22
16	Rao Majra	ACTHoM	1	3	8	ACTHoM	1	2	6
17	Shekpura	ALTHoP	2	3	25	ALTHoP	3	5	86
18	Daun Kalan	ALTHoP	2	3	55	ACTHoP	1	2	70
19	Dhareri Jattan	ALTHoP	3	8	132	ALTHoP	3	10	154
20	Janherian	ACTHoP	1	1	10	ALTHoP	3	5	75
21	Shankarpur	ALTHoM	2	4	32	ACTHoP	1	1	40
	Total		40	90	979		42	84	1381

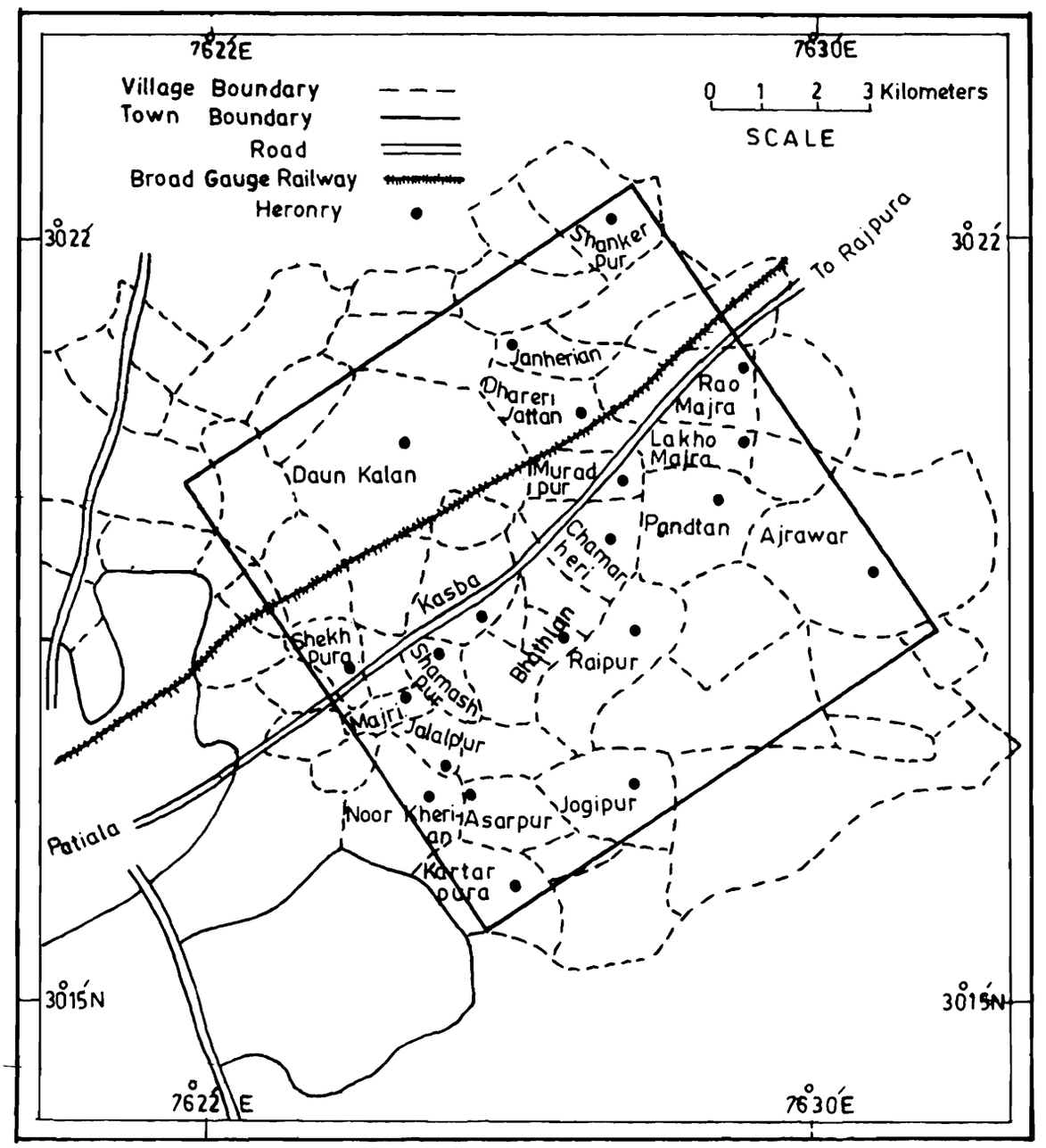

Fig. 43. heronries in quadrat-2 during 1983 and 1984.

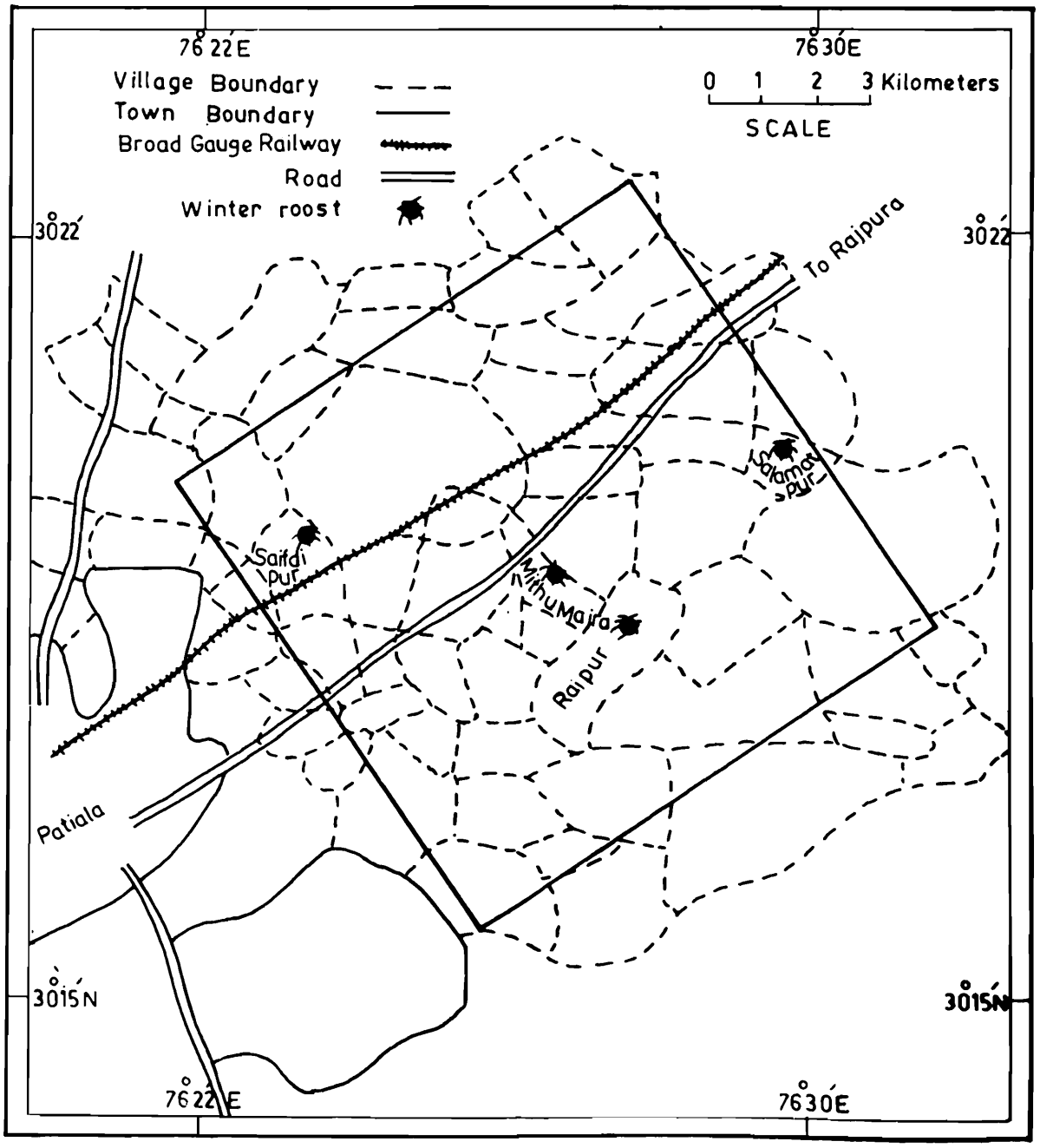

Fig. 44. Location of winter roosts in quadrat-2 during 1983.

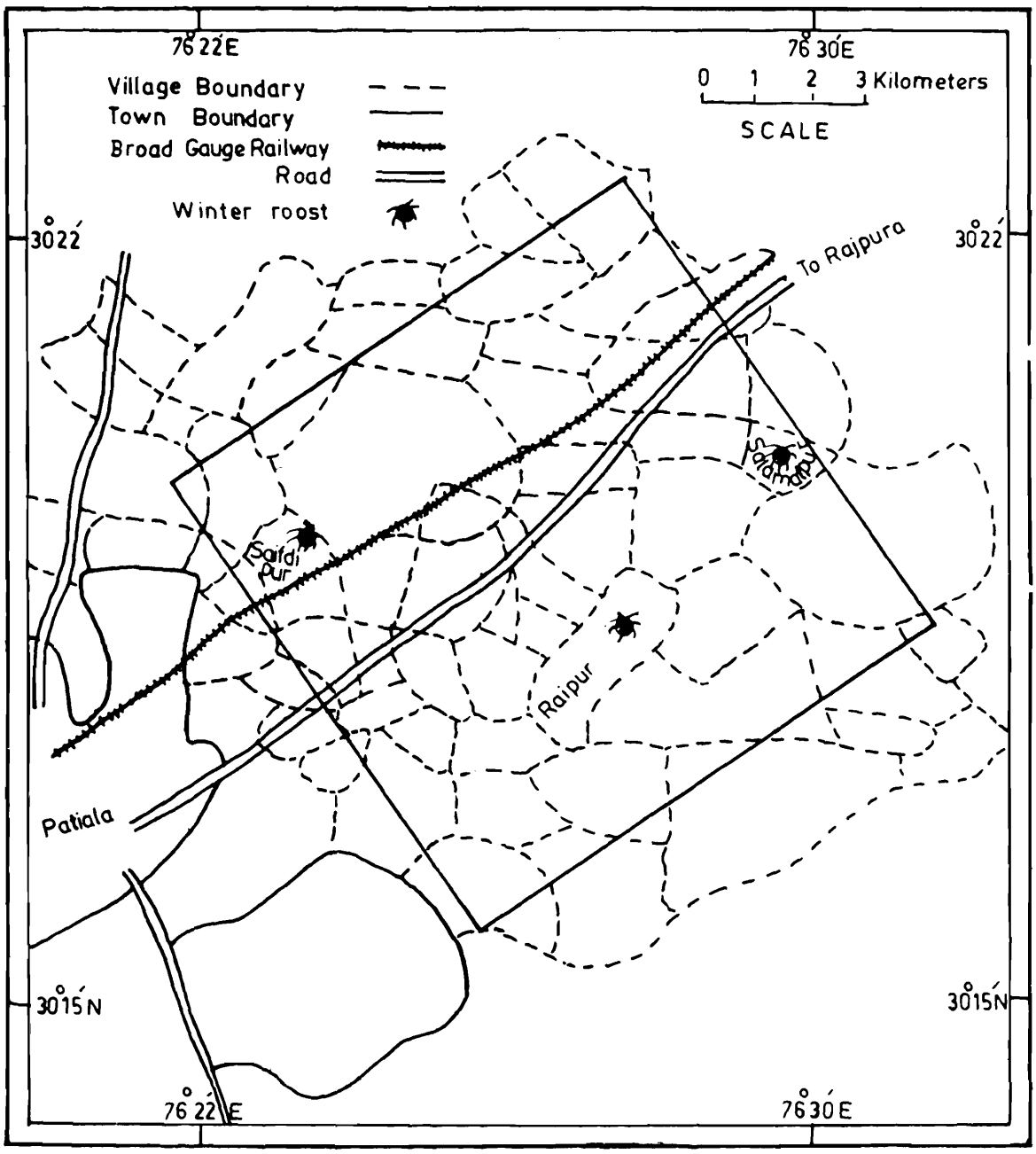

Fig. 45. Location of winter roosts in quadrat-2 during 1984.

Four winter roosts were present in the quadrat-2 when Christmas counts were made in December, 1983 (Fig. 44). Out of the four roosts, three were associated with human habitation and were on *Ficus bengalensis* trees while one roost of Mithu Majra was not associated with human habitation and was on *Dalbergia sissoo* trees. All the four roosts in quadrat-2 were mixed roosts. Winter population of *B.i. coromandus* in quadrat-2 in four winter roosts was, 68 Cattle Egrets in Mithu Majra roost, 154 in Raipur roost, 61 in Salamatpur and 20 in Saifdipur roost. Total winter population was 303 i.e. a winter population density of 3.03 Cattle Egrets per sq. km. In this quadrat there was a decrease in numbers from 1958 breeding Cattle Egrets to 303 (total winter population).

During 1984 the number of heronries remained the same i.e. 21 but the number of breeding pairs of *B.i. coromandus* increased to 1381 i.e., 2762 breeding Cattle Egrets resulting into breeding population density of 27.62 egrets per sq. km. All the heronries during 1984 were Homogeneous and were on *Acacia arabica* trees.

Winter counts during 1984 revealed that one roost at Mithu Majra was deserted (Fig. 45) and three previously existing roots contained 530 Cattle Egrets. These winter roosts contained 523 *B.i. coromandus,* the winter population density in this quadrat being 5.23 egrets per sq. km.

6.23 QUADRAT -3

Quadrat-3 is located 30°14′ N to 30°20 N and 75°28′ E to 75°35′ E. Main Kharif crops are paddy (approximately 50%) and cotton (approximately 40%) of the total cultivated land in quadrat-3. The main Rabi crop is wheat.

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During 1983 there were three heronries in quadrat-3 (Fig. 46). These heronries carried 245 nests of *B.i. coromandus* (Table 43), resulting in breeding population density of 4.9 Cattle Egrets per sq. km.

Out of the three heronries during 1983, two were Homogeneous heronries constituted by *Acacia arabica* trees while Dhanaula heronry was Heterogeneous heronry. During 1983, out of the 245 nests in the quadrat, 156 (63.7%) nests were harboured by *A. arabica,* 57 (23.2%) nests were on *Morus alba,* 23 (9.3%) nests were on *Zizyphus jujuba* and 9 (3.6%) nests were on *Melia azadirachta* trees.

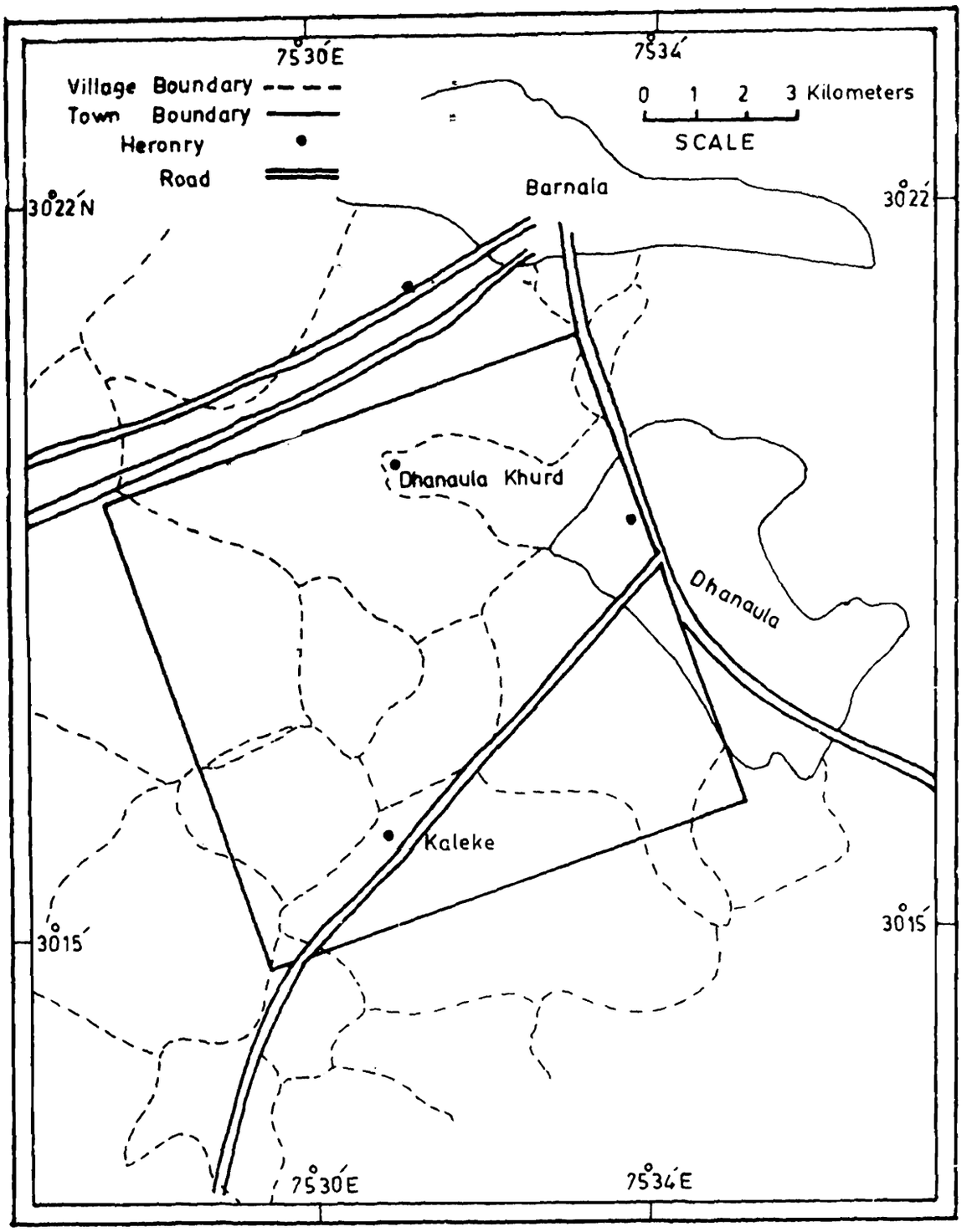

Fig. 46. Location of heronries in quadrat-3 during 1983.

Table 43: Results of the censuses of **heronries in** quadrat- 3 during 1983-84

Sr. No.	Name of heronry	1983 Type of heronry	1983 No. of section	1983 No. of trees	1983 No. of nests counted	1984 Type of heronry	1984 No. of section	1984 No. of trees	1984 No. of nests counted
1	Dhanaula	ACTHoM	1	8	87	ACTHoM	1	6	169
2	Dhanala Khurd	ACTHoP	1	2	36	Deserted	—	—	—
3	Kaleke	ACTHoM	1	21	122	ACTHoM	1	22	135
	Total		3	31	245		2	28	304

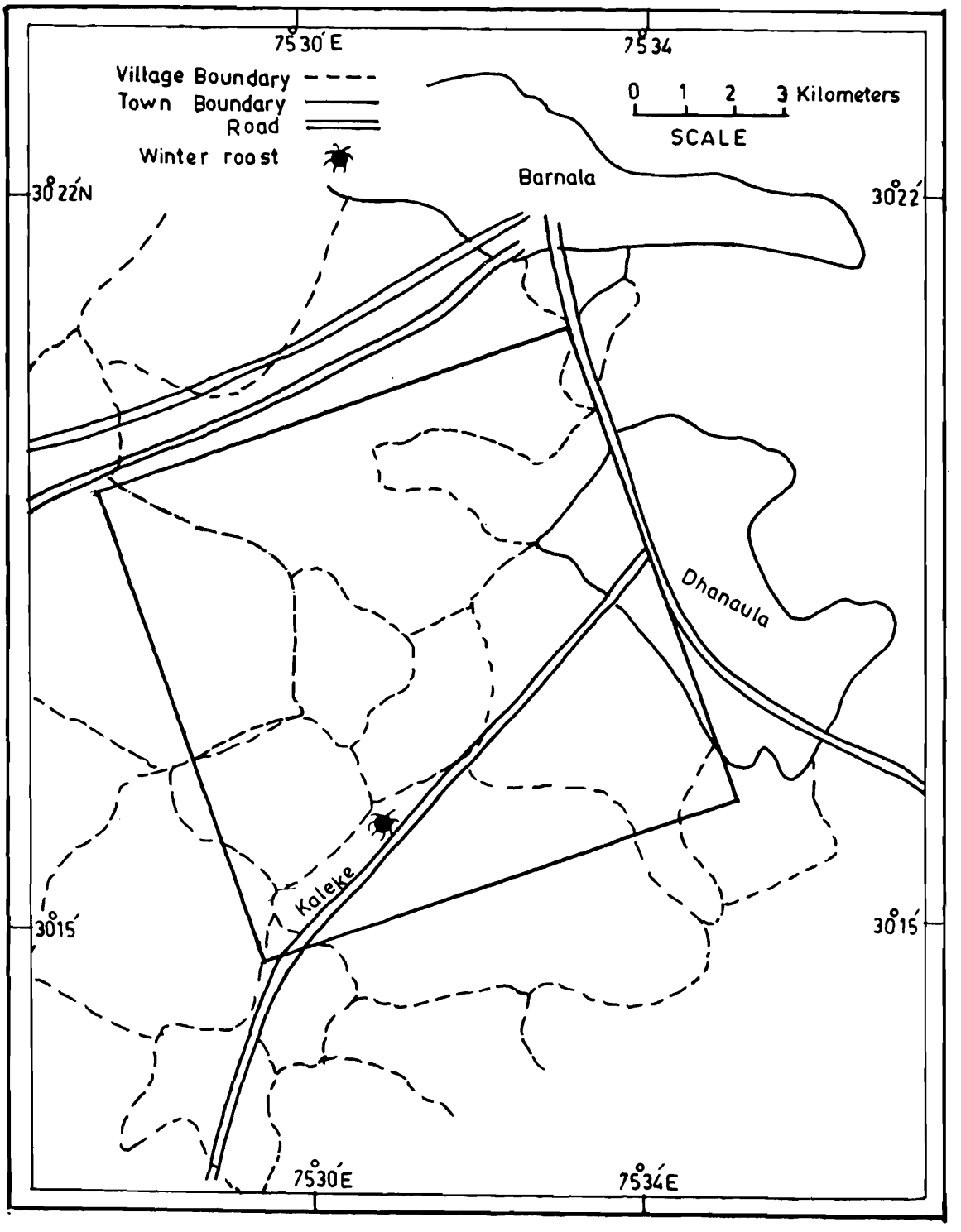

Fig. 47. Location of winter roost in quadrat-3 during 1983 and 1984.

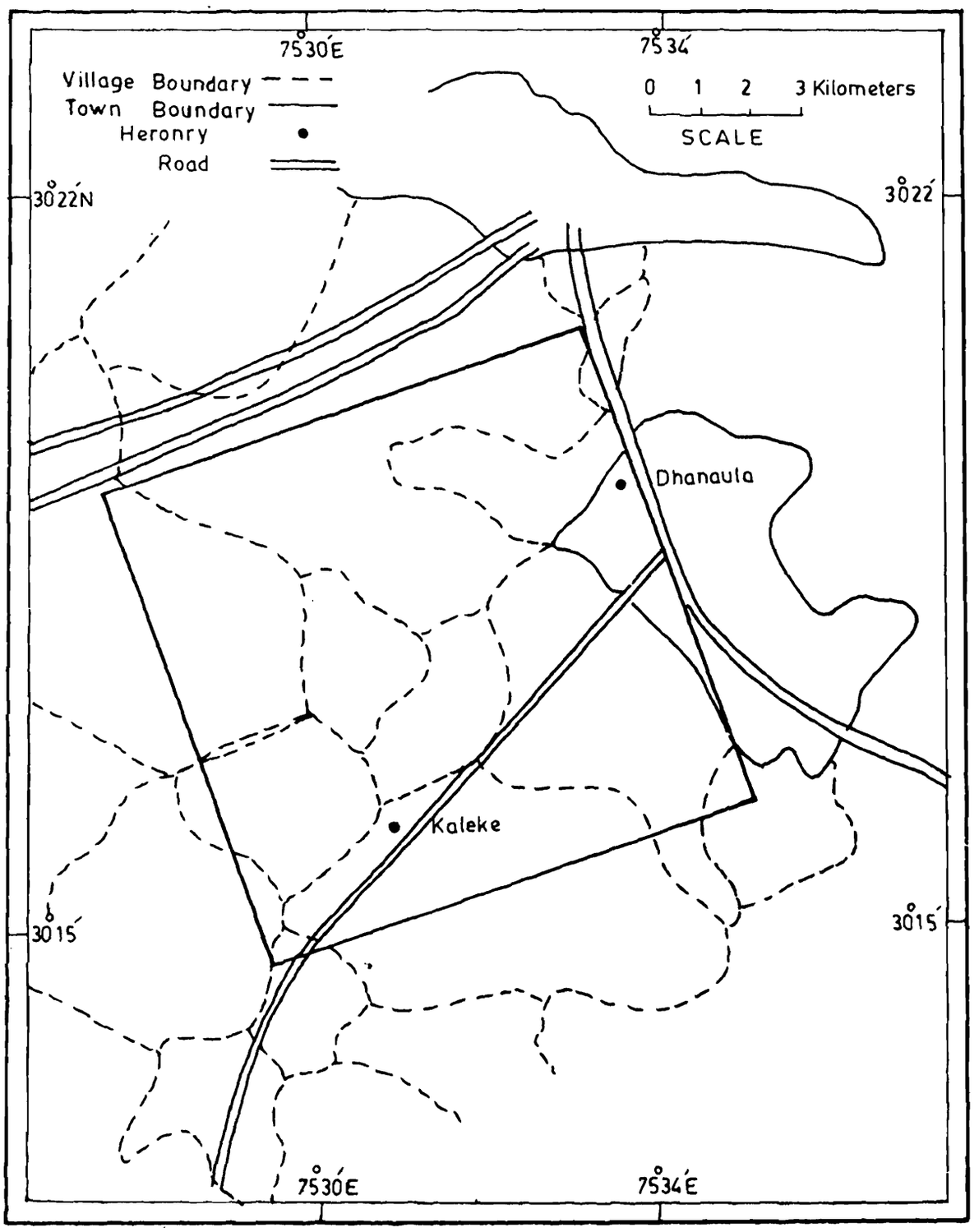

Fig. 48. Location of heronries in quadrat-3 during 1984.

During 1983 there was one winter roost located at Kaleke village (Fig. 47). This roost was constituted by one large tree of *Ficus bengalensis* and three trees of *Acacia arabica*. This roost contained 523 Cattle Egrets resulting into winter population density of 5.23 egrets per sq. km.

During 1984, nesting trees at Dhanaula Khurd were felled by villagers leaving only two heronries in the quadrat-3 (Fig. 48). The remaining two heronries contained 304 nests i.e. 608 breeding Cattle Egrets, resulting in the breeding population density of 6.08 egrets per sq. km.

During winter 1984, the previously existing roost at Kaleke contained 676 Cattle Egrets resulting in winter population density of 6.76 egrets per sq. km.

6.24 QUADRAT -4

This quadrat is located at 30° 11′ N to 30° 17′ N and 74°58′ E to 75°04′ E. The main Kharif crop is cotton in this quadrat covering approximately 75% of the total cultivated land. Paddy is also grown in approximately 20% of the total cultivated land. Rabi crop is wheat in this quadrat.

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Surveys made during the summers of 1984 showed that *B.i. coromandus* did not breed in this quadrat as no heronry was found. During winter 1983, a single winter roost was located in Bhatinda town (Fig. 49), which carried 1319 Cattle Egrets. This roost was constituted mainly by *Ficus bengalensis* and *Melia azadirachta*. This was a mixed roost. The winter population density of *B.i. coromandus* was 13.19 egrets per sq. km. in this quadrat.

During 1984 the main trees of *Ficus bengalensis* and *Melia azadirachta* were felled. The population of *B.i. coromandus* in that roost decreased to 486 as the egrets shifted to *Dalbergia sisso* trees. A new roost at Choti Bhuchu was, however, formed which harboured 821 Cattle Egrets (Fig. 50). This roost comprised three trees of *Ficus bengalensis*. The winter population density in this quadrat was 13.07 egrets per sq. km.

6.25 CONCLUSIONS

The following conclusions emerge from the reports of censuses.

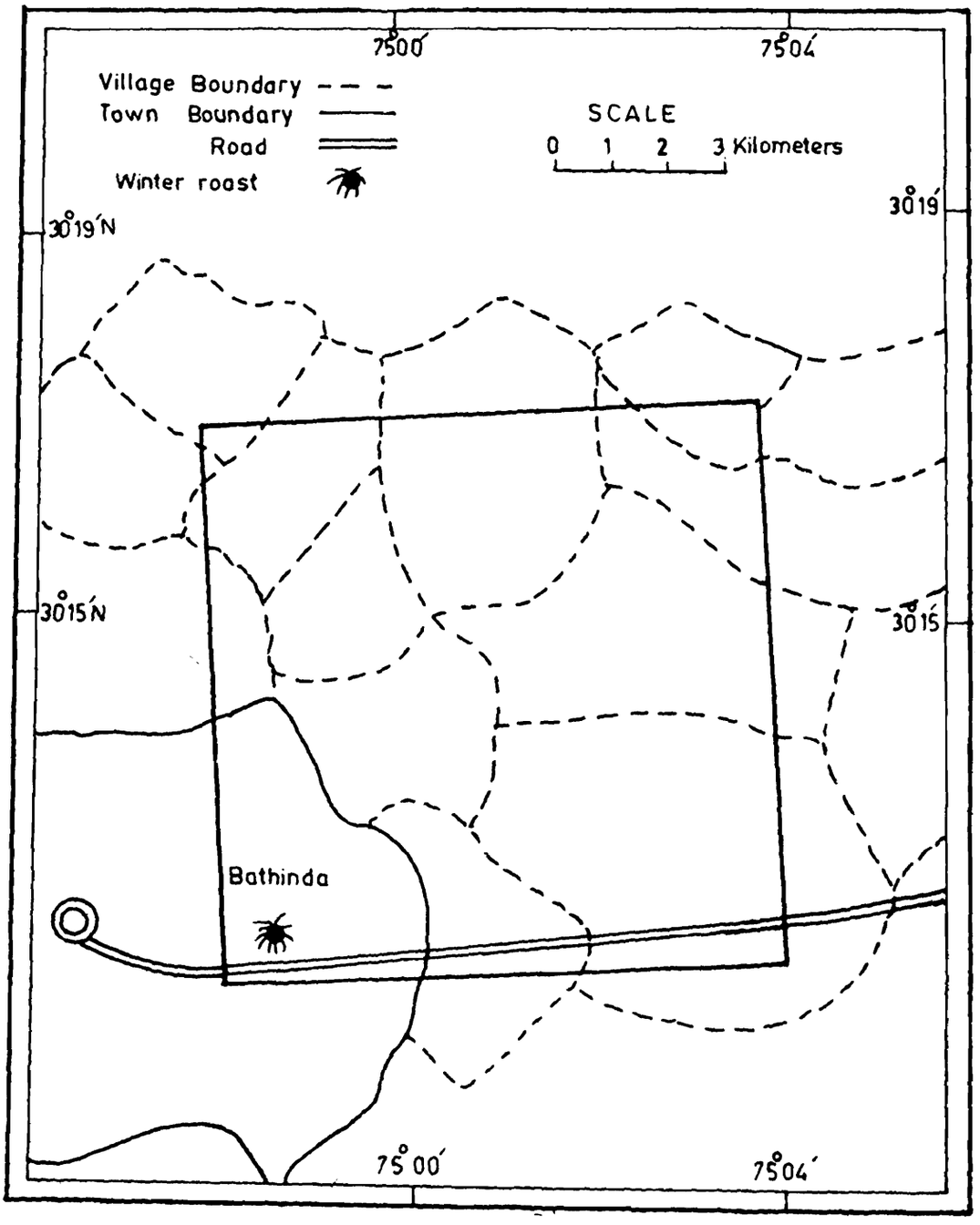

Fig. 49. Location of winter roost in quadrat-4 during 1984.

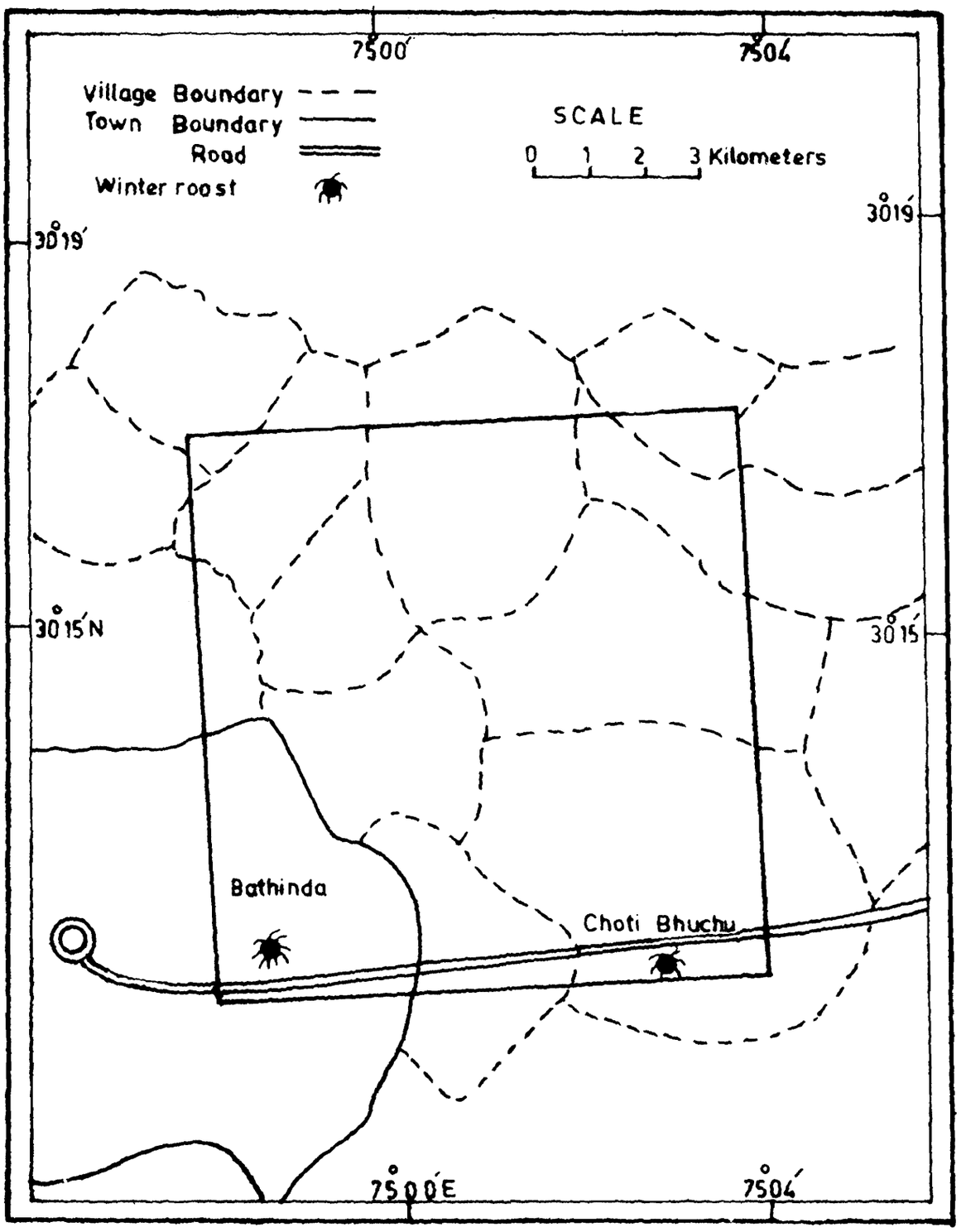

Fig. 50. Location of winter roosts in quadrat-4 during 1984.

The breeding population of Cattle Egret seems to be regulated by two main factors, viz. density of villages/towns and paddy cultivation. Villages/towns provide nesting places for this species (see 4.41). Paddy is the main foraging ground of the Cattle Egret during breeding season.

Density of villages/towns was highest i.e. 0.79 per sq. km. in the quadrat-1 of district Rupnagar, while it was 0.47, 0.13 and 0.11 per sq. km. in quadrats 2, 3 and 4 respectively. Quadrat-1 carried maximum number of villages that could provide breeding sites for the Cattle Egret but the paddy cultivation was low (25%) in this area as compared to quadrat 2 (85%). Hence, the breeding population densities of *B.i. coromandus* was slightly higher in quadrat-2, i.e. 19.58 egrets per sq. km. as compared to 18.34 egrets per sq. km. during 1983 and was 27.62 egrets per sq. km. as compared to 21.46 egrets per sq. km. in 1984. The breeding population density of *B.i. coromandus* was quite low in quadrat-3, 4.90 and 6.04 egrets per sq. km. during 1983 and 1984 respectively, because it has very low density of villages/towns (0.13 per sq. km.) and paddy cultivation was also quite low (50%) as compared to quadrat-2. Quadrat-4, which was the part of Southern dry zone of Punjab, had the lowest density of villages/towns (0.11 per sq. km.) and minimum paddy cultivation (20%). In this quadrat the Cattle Egrets did not breed because of the scarcity of nesting places and foraging grounds.

However, the winter population densities were quite reverse in the quadrats. Winter population densities were the highest (13.19 egrets per sq. km. during 1983 and 13.07 egrets per sq. km. during 1984) in quadrat-4 which carried no breeding population of Cattle Egrets. The winter population densities were 5.23 and 6.08 egrets per sq. km., in quadrat-3, 3.0 and 5.3 per sq. km. in quadrat-2 and 0.89 and nil egrets per sq. km. in quadrat-1 during 1983 and 1984 respectively.

Cotton crop is infested by a number of insect-pests. During winter when the cotton plants are uprooted and fields are watered and ploughed, these areas form an ideal foraging grounds for the Cattle Egrets. Moreover, these areas are not scanned by the Cattle Egret during summer resulting in a buildup of insect population which forms the food of the bird during winter season.

7. SUMMARY

In this monograph three major aspects of biology, viz. breeding biology, feeding ecology, and population density of the Cattle Egret, *B.i. coromandus* have been studied.

There is a single annual breeding season in case of *B.i. coromandus*, starting in the first to second week of May and terminating in the first to second week of September. The breeding in this case is asynchronous which leads to the longer breeding spans of colonies as compared to individual egrets. Food, longer day length and nesting condition are the main initiating factors for the breeding season. The development of colonies starts with the successful roosting of a flock of Cattle Egrets.

The breeding territory in case of *B.i. coromandus* is of "Narrowly restricted" type. The breeding territory is acquired by male with the onset of breeding season. This territory is defended by male and female alternately during incubation and brooding. Nestlings defend the territory after brooding till they leave the nests. Territory is defended with Forward Display.

The buff-coloured plumage on head, neck and back starts appearing in mid-March that results into white and buff-coloured egrets in mid-April. The colour of beak, lores and irises also changes. The male after acquiring territory performs a variety of courtship displays. The female attends the actively courting male and also performs few courtship displays. Downward Display is performed by the male. This display comprises the downward snap of neck with the bobbing of body. This display is being reported for the first time in Cattle Egret and family Ardeidae. Twig shake comprises the sideways shaking of twigs and is performed by both the sexes. Wing Touch is a ritualized displacement activity which is very much frequent in both the sexes. Stretch Display is a distance reducing display, frequent in males before pair-formation and in females after pair-formation. Flap Flight Display is a ritualized flight activity performed by both the sexes before pair-formation; it ceases to occur after pair-formation in female while males continue with it a few days after pair formation. Wing spread is performed by males before pair-formation. During courtship displays the female tries to land on courting male so as to subdue its aggression for forming a pair Pair-formation takes place when a female succeeds to land on male's back. Back-biting follows the pair-formation and helps to strengthen the pair-bond. Pair-bond in this case is monogamous and exists only during the breeding season. Copulation is followed by Stretch Display performed by females before the start of nest construction and by Greeting Ceremony after the start of nest construction.

Heronries of *B.i. coromandus* are located on trees in villages. Association of Cattle Egret with human habitation helps to reduce egg-loss due to dust-storms and gales. The presence of water ponds in villages provides bulky food elements and facility for dipping their feathers in the vicinity of nesting sites. *Acacia arabica* trees are preferred to other trees for nesting. *A. arabica* trees are thorny in nature and, therefore, protect the nests of *B.i. coromandus* from human intrusion. The heronries in the present study are being classified on the basis of location (Associated and Free heronries), physiognomy (Compact and Loose heronries), general plant types (Tree or Reed heronries), plant types (Homogeneous or Heterogeneous) and on the basis of resident heron/egret species (Mixed and Pure heronries). A combination of all these types are used to describe a heronry. The nests are located at considerable height, more than three times the average height of man. The maximum distance which Cattle Egret maintains in human habitation is being called human distance. Temporal occupation of different sections of heronries, depends upon the height preference for the previously existing sections. Male brings the twigs, one by one and female does most of the construction work. There are three nest construction techniques in case of *B.i. coromandus,* "push and pull" a twig breaking activity in male, "aim and arrange" a twig adjustment activity in female and "tremble-shove" a twig pushing activity in both the sexes. Nest construction continues up to first hatching. In the cases where the old nests are occupied, the time taken from the start of nest construction to the first laying is less as compared to the cases where new nests are formed. Twigs of different trees and plants are used to construct the nests. Twigs of the same type as that of nesting tree are used for camouflaging nests. Heavy, long and thicker twigs are used to construct the base and middle part of nest, while the upper part is formed by light, short and thinner twigs. Spined twigs are used in higher percentage in the cases where less number of rough twigs are used. Nesting association with wasp *Polistis hebraeus* is commensalism and helps to minimise the dangers of human instrusion.

Eggs are moderately long, broad and heavy. The colour of eggs varies from light sky-blue, sea-green, white to pinkish white. Most of the eggs are oval but other shapes as biconical and elliptical are also frequent. The eggs are generally laid during night or in early morning. The laying interval of eggs is more in the last eggs of clutches as compared to the first ones. Clutch-size is determinate and varies from 3 to 5 eggs with an exception of 7

eggs. Quite a good number of eggs are lost due to gales and dust-storms. The extent of egg-loss depends upon the protective situation of heronry in villages. Clutches are replaced if all the eggs are lost.

Incubation starts with the laying of first egg Both male and female incubate the eggs alternately. Attentive periods at nest are very high. The adults take water dips in order to cool their eggs during extreme hot conditions. Shading of eggs, incubation and wet-incubation vary with the ambient teperature. Incubation period is 23.8 ± 0.93 days in this case.

The hatching starts with the pipping of egg. More cracks appear and move in a line in anti-clockwise direction to cut a half rim. This rim is separated by pushing from within the egg. The hatchlings are semi-altricial having tracts of downs and having open eyes. Hatching failure is caused by the smearing of eggs with the droppings of nestlings. Hatching failure is more in the last eggs as compared to the first ones.

In the chicks, different body parts, feathered and unfeathered, grow with the subsequent age. The growth in the weight of chicks is more in the first four nestlings as compared to the fifth one. The chicks are fed by both the parents alternately during brooding; freely and frequently after brooding. The chick mortality is caused by the falls from the nesting trees. Red mite attack also occurred at Bharaunjian heronry and caused a considerable loss of chicks. Comfort activities start developing in chicks with their subsequent growth. Gular flutter is common from the very first day and serves as a cooling device for nestlings during high ambient temperatures. The flight in nestlings is developed by vigorous flapping of wings which starts after 20 days of age. The nestling period in this case is 31.6 ± 1.98 days and the post-nestling period ranges from 21 to 27 days. Nestling success is fairly high due to the absence of any predator. The breeding success was 49.8% and 42.2% for 1983 and 1984 respectively.

The most frequently used foraging behaviour by the Cattle Egret is slow walking. The Cattle Egret usually forages in terrestrial habitats. In these it prefers irrigated pastures to dry ones, and faces very little competition from other herons. The Cattle Egret generally feeds in single - species flocks. The flock feeding Cattle Egrets catch more prey than the solo feeders. It appears that the Cattle Egret, in flocks, forages by opportunist scrambling. While foraging, the Cattle Egret often associates itself with mammals or farm machinery. The associated egrets spend less energy in search of prey and

gain more energy as a food intake, in the same habitat. The cattle are also benefited by the association. This association can be termed as proto-cooperation.

To study the diet of the Cattle Egret, 95 food samples were analysed. From the analysis of the diet of the Cattle Egret it is evident that it is mainly an insect eater. The length of the food items varied from 3-215 mm., the mean length being 10.5 mm. There is some seasonal variation in the diet of the Cattle Egret. This seasonal variation appears to be due to availability of a particular food item in nature.

To study the regional variation in the diet of the Cattle Egret, the data of the present study are compared with seven previous studies from different regions. The regional variation in the diet of the Cattle Egret seems to be due to different faunal distribution in different regions rather than different feeding preference of the Cattle Egret.

Two areas for the study of population of Cattle Egret were selected, one was the Union Territory, Chandigarh and the other was Punjab state. Four quadrats of 10 × 10 sq. km. from Punjab state were selected from the different topographical and agricultural areas.

Heronries were located in villages in the Union Territory, Chandigarh. The breeding population density in the Union Territory was 6.96 Cattle Egrets per sq. km. and 5.77 Cattle Egrets per sq. km. during the years 1983 and 1984 respectivelly. This decrease in breeding population density was due to the desertion of heronries caused by human disturbance. The winter population densities in both the years of study in the Union Territory was nil as no winter roost was found. This shows the trend of seasonal migration of the Cattle Egret in Union Territory.

In the quadrats of Punjab, the population densities of the Cattle Egret depended mainly on density of villages towns and paddy cultivation. The quadrats having higher village/town density and high percentage of paddy cultivation had the maximum population density of the Cattle Egrets. The quadrat having minimum paddy cultivation and lowest village/town density was the quadrat where the Cattle Egrets did not breed.

The winter population density of the Cattle Egret, however, differed from this trend. The quadrats having cotton cultivated lands had maximum winter population densities of the Cattle Egrets. This was due to the availability of more food in these areas during winter.

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