BREEDING BIOLOGY OF THE INDIAN MYNA IN CITY AND AVIARY

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ABSTRACT

In Auckland breeding occurs between late October and mid-April. During the 1970-71 breeding season 37% of territories were formed from undefended home ranges held during winter; remaining territories were created by non-residential pairs. Territories were defended by both sexes and averaged 0.83 ha.

Mynas nest in holes and crevices. Nests average seven days to build. Average clutch size for aviaries was 3.9 eggs. Incubation begins with laying of the second egg and lasts 16 days for first egg of a clutch and 13 days for last egg. Nestling period is about four weeks. Only females sit on the nest at night.

In total, 55% of all nests failed completely, and only 60% of pairs produced fledglings, from 24 single and eight double broods. Nesting success was 22%. Starvation of nestlings, disturbances and possibly shortages of food for adults were responsible for most mortality in nests.

Similarity of open woodland and urban habitats, omnivorous feeding habits and hole-nesting have pre-adapted Mynas for association with man. Mynas in Auckland, like several species of birds in European cities, did not experience shortages of food during winter and had smaller clutches, longer breeding seasons and higher densities than conspecifics in rural habitats.

INTRODUCTION

Populations of birds in cities have higher densities, more stable supplies of food and water, longer breeding seasons, lower rates of mortality and smaller clutch sizes than populations of the same species in natural habitats (Erz 1966). These conclusions are based primarily on studies of House Sparrows, *Passer domesticus,* (*e.g.* Summers-Smith 1963), Robins, *Erithacus rubecula,* (*e.g.* Lack 1943) and Blackbirds, *Turdus merula,* (*e.g.* Snow 1958) in Europe where feeding, roosting and breeding of these and other birds alongside man are relatively recent occurrences. The Indian Myna, *Acridotheres tristis,* on the other hand, has been associated with man for many centuries (see Sengupta 1968: 1) and is probably one of the oldest species of urbanized birds in the world. This study considers the breeding biology of the Myna in Auckland (population in 1971: 698,000), New Zealand and suggests to what extent conclusions from studies of other urbanized birds are true for this species.

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In New Zealand the Myna is common in most towns and cultivated areas, but rare in other habitats, in the North Island north of Latitude 40°S (Bull & Gaze 1972).

METHODS

I observed four pairs of Mynas in four separate aviaries from October 1969 to June 1970 and free birds in a study area of about 240 ha. in the centre of Auckland (see Fig. 1) from October 1970 to April 1971. Birds in aviaries provided data not obtained from nests in the field; details of aviaries and maintenance of birds have been recorded elsewhere (Counsilman 1971). In the field I distinguished pairs primarily by their location and their relation to nests and secondarily by physical defects, vocalizations and colour-rings. As most nests were inaccessible to me, I determined whether they contained eggs or nestlings by behaviour of the pair.

I captured birds for aviaries and for banding and releasing using a narcotic, alpha-chloralose, added at 0.75% by weight to small cubes (2 x 2 x 2 cm) of bread (P. R. Wilson *in litt.*). There was about 40% mortality with this method. Dead birds were examined for sexual differences in colouration, weight and body measurements. Eight specimens were collected on 20 July 1969, 24 on 11 August 1969 and 41 on 24 September 1970 between three and 20 km north of Auckland. No baiting was done in the study area.

Results were evaluated statistically by Student's ' t ' for tests of significance (Backhouse 1967).

RESULTS

Specimens:

Males are significantly larger than females for weight and for length of body, wing, tail and tarsus but not for length of beak (Table 1; but *cf* Vyas 1964). Both sexes in New Zealand are much heavier than their counterparts in India: mean weights of 17 males and 11 females from Indian (Vyas 1964) are 62% and 60%, respectively, of mean weights of males and females in Table 1.

Sexes are alike in colouration in India (Whistler 1949) and New Zealand, but females are reported to be lighter in colour than males in South Africa (Mackworth-Praed & Grant 1963) and Hawaii (Eddinger 1967).

Territory:

The breeding seasons of 1969-70 and 1970-71 began in October with first territorial disputes and ended in mid-April with last separations of fledglings from adults. Start of both seasons coincided with a rise in mean monthly temperature to 16°C, a rise in monthly hours of sunshine to 200 and a drop in monthly rainfall to less than 100 mm. End of both seasons coincided with reverse trends. Mynas breed late compared to three other species of passerines common in Auckland (Blackbird, House Sparrow and Starling), all of which have fledglings by late October.

Table 1. Weights and body measurements of specimens[1]

	N	Weight (gms)[2]	Total Length (mm)[2]	Wing (mm)[2]	Tail (mm)[2]	Tarsus (mm)[3]	Beak (mm)[4]
Males	32	130.5±8.2	256.8±6.1	140.7±3.5	86.3±3.5	37.8±3.2	21.8±1.5
Females	33	115.0±6.8	245.2±7.8	133.7±3.1	80.7±3.7	35.5±2.0	21.2±1.4
Both Sexes	65	122.6±10.8	250.9±9.1	137.2±4.8	83.5±4.6	36.6±2.9	21.4±1.5

1 Measurements follow Pettingill (1964)

2 A significant difference exists between males and females ($P < 0.001$).

3 A significant difference exists between males and females ($P < 0.01$).

4 No significant difference exists between males and females ($P > 0.05$).

Reproduction both years was preceded by formation of a summer roost near the Kiosk of the Auckland Domain in late October; this roost was abandoned in late January 1970 and early February 1971. Other communal roosts in the study area were occupied throughout the year (see Fig. 1). Daily movements of solitary birds, pairs and flocks in relation to communal sleeping have been discussed in another paper (see Counsilman 1974). Except during evening and at night pairs are the only social class that regularly visit the study area, though occasionally unmated birds and flocks of three to 20 birds pass through the area. Virginal formation of pairs occurs within flocks (Wilson 1973, Counsilman in prep.). After their first success in breeding pairs usually mate for life (Wilson 1973) and many occupy undefended home ranges during the non-breeding season as well as territories during the breeding season.

In India territories of Mynas are ' Type C ' of Hinde (1956), a small area around the nest (Sengupta 1968), but in New Zealand they are ' Type A,' a large breeding area in which nesting occurs and most food is collected. Fifty-three territories were formed wholly or partially within the study area during the breeding season of 1970-71 (Fig. 1). Twenty developed from home ranges in late October, and the remainder were formed by non-residential pairs between early November and late December (Table 2). Some territories and home ranges (*e.g.* Nos. 2, 3 and 16) were occupied throughout this study (19 months), while two territories in which some nesting behaviour occurred were occupied for only one and two weeks (Nos. 9 and 43). One area was visited daily by six to eight pairs for seven weeks before Territories 8 and 18 were formed; neither pair produced fledgelings. In three instances pairs deserted territories (Nos. 36, 39 and 51) for several weeks or were replaced by different pairs; new or returning pairs did not breed.

FIGURE 1 — Aerial photograph of study area in Auckland with inclusive and bordering territories of 53 pairs during 1970-1971 breeding season. Communal roosts: KR = Kiosk, FR = Foundation and PR = Parnell.

The territory is defended by both sexes with calls, supplanting attacks and physical combat. Fights were common early in the season but rare after mid-January when most pairs had occupied nests or fledgelings.

Table 2. Number of pairs present and number and percent of pairs with eggs, nestlings or fledgelings in study area each week during 1970-1971 breeding season.

	November				December				January				February				March				April		
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Number of pairs present	20	20	27	39	44	41	43	43	45	45	45	44	45	44	40	37	34	31	27	35	26	30	25
Number and percent of pairs with eggs, nestlings or fledgelings	3	6	14	24	33	33	33	35	40	41	40	37	41	39	35	32	30	22	15	10	9	7	4
	15%	30	52	62	75	80	77	81	89	91	89	84	91%	89	88	86	88	71	56	40	35	23	16

Most pairs spent part of each day oustide their territory, though this varied with location, stage of reproduction, time of day and day of week. Some pairs (*e.g.* Nos. 2 and 3) rarely left their territories during the day, and most pairs with occupied nests only left for short periods. Between about 0800 and 1730 on a weekday a few pairs were frequently absent from their territories because of disturbances by vehicles and pedestrians. But, on Saturdays, Sundays and public holidays these pairs made fewer trips outside their territories because disturbances were fewer.

Mynas possess vocalizations, tentatively termed " Loud calls," which appear to serve to maintain pair bonds throughout the year and to proclaim a territory during the breeding season. In aviaries, males gave about twice as many Loud calls as females; they also made more supplanting and physical attacks on live birds placed in a pair's aviary. Calling can be heard any time of day, but there is a peak in the morning shortly after the pair's or male's arrival in the territory. First calls of the morning are usually given from a building, but they may also be given on the ground. When a mate is lost during the breeding season Loud calls also serve as advertisements to unmated individuals of the opposite sex. (A bird that loses its mate during the non-breeding season probably joins a flock to acquire a new mate.) I recorded extended periods of calling for a male in an aviary after his mate died and for a bird of unknown sex in Territory 39 who called at least 293 times, during 40 minutes. Mates rarely remain separated for more than 30 minutes. The greatest number of Loud calls I recorded for a mated bird during a single bout was 83.

Distribution of territories was related to six subhabitats. Mynas did not visit native bush of the Domain (east of Territory 17). Grassland of the Domain contained more than half of Territories 10 and 20 but lacked sites for nests within itself; it was used extensively as feeding grounds by many Mynas. Bare ground of Grafton Gully supported parts of Territories 27, 37, 40 and 42 but was used little for foraging. Areas with a high density of buildings and pavement, *e.g.* Queen Street, supported only two territories (Nos. 14 and 44), while open woodland of the Domain held 10 (Nos. 2, 3, 8, 18, 26, 31, 33, 48, 51 and 53). Areas with buildings and pavement interspersed with parks and gardens held the remaining 39 territories (Nos. 1, 4-7, 9, 11-13, 15-17, 19, 21-25, 27-30, 32, 34-43, 45-47, 49, 50 and 52). Mean size of 51 territories (excluding Nos. 9 and 43) was 0.83 ha. (S.D. ± 0.27) with smallest (No. 8) 0.09 ha. and largest (No. 36) 1.38 ha. There was no significant difference ($P > 0.05$) in sizes of territories between open woodland and areas with a moderate density of buildings and pavement.

Food:

No systematic study of food was made (see Wilson 1965). Mynas forage intensively on and beside roads in the early morning. Disturbances later in the day appear to be responsible for early foraging by urban birds (Strawinski 1963), but for the Myna other activities at other times of the day and availability of food along roads may also favour this behaviour (Wilson *in lett.*). In rural areas dead insects are the major items taken from roads, but in the city bread and other litter are taken as well. After early morning most foraging is in grassy areas and orchards where live insects, fruit and possibly some grains (see Editor's Note, *J. Bombay Nat. Hist. Soc.* 1930: 807) are taken. In the city the only items eaten that are not regularly taken on the ground are cicadas (*Amphisalta* spp.), which Mynas capture in trees, on buildings and on telephone poles.

Interspecific Encounters:

House Sparrows, Starlings and, to a lesser extent, Red-billed Gulls *(Larus scopulinus)*, Black-backed Gulls *(L. dominicanus)*, Blackbirds and Rock Pigeons *(Columba livia)* also forage on and beside roads in the early morning. I have observed disputes between all of these species and Mynas. These encounters are probably not important to any species in defence or acquisition of a significant supply of food because disputed items are often left uneaten. Encounters between Mynas and Starlings are very common. The Myna clearly dominates the smaller Starling at roosts, nest-sites and over food. Although Mynas attack adults, eggs and nestlings of Starlings, they are unsuccessful in preventing this species from breeding in the city because of the large number of nest-sites Starlings can enter that Mynas can not. At

Havelock North Wilson (1973) found nesting success of Starlings to be almost nil at sites Mynas could enter. Blackbirds tried to rob Mynas of food on six occasions and were twice successful, while Mynas tried to rob Blackbirds on three occasions but were not successful. Mynas mobbed Black-backed Gulls, Red-billed Gulls, cats and humans that came near occupied nests.

Reproduction:

1. Sites of Nests and Construction —

Mynas nest in holes and crevices. Table 3 lists numbers and percentages of sites used to three stages of reproduction. The most frequently used as well as most successful site was located under metal roofs of private houses. These sites were well protected from weather, and rats may have been the primary detrimental factor directly affecting the nests. One roof-nest (in Territory 12) was destroyed when a house was demolished and three nests in drains (in Territories

Table 3. Nest-sites used to three stages of reproduction.

Site	Incubation	Nestlings	Fledgelings[1]
Under metal roof; gutter entrance	17(25%)	16(31%)	14(41%)
In drain funnel on roof	12(18%)	8(15%)	5(14.5%)
Air vent	10(15%)	8(15%)	5(14.5%)
Vegetation: tree, palm and ivy	7(11%)	6(11%)	2(6%)
Crevice, beside a pipe	5(7%)	4(8%)	3(9%)
Attic; wall hole entrance	5(7%)	3(6%)	2(6%)
Under roof tiles	5(7%)	3(6%)	2(6%)
Between drain and wall	4(6%)	3(6%)	1(3%)
Street lamp	1(2%)	1(2%)	0
Construction crane	1(2%)	0	0
Totals:	67(100%)	52(100%)	34(100%)
Number of pairs involved	47	44	32

[1] Refers to nest-sites from which fledgelings were produced

3, 19 and 23) were ruined by rain. Two nests (in Territories 26 and 40) were apparently abandoned because of repeated difficulties in entering the sites, in air vents. In Auckland 11% of nests were in vegetation compared with 32% in Honolulu (Eddinger 1967).

Height of nests varied from 1.5 m to about 25 m, with an average of about seven metres.

For their first nest of the season a pair usually spent several days inspecting holes and crevices. One bird (the female in aviaries) does most of the inspecting and chooses the final site; the mate perches nearby, calls and may give Head-bowing displays (see Counsilman 1971 and in prep.). Once a site is chosen, pairs (probably especially the male) continue to inspect holes, either as a continuing response to nesting Starlings or in anticipation of changing sites. One pair (No. 12) began building at a new site within several hours after the destruction of their previous nest. Three pairs (Nos. 11, 12 and 29) each with two consecutive failures of occupied nests spent between one and two weeks inspecting sites; and, one pair (No. 48) tried for three weeks to build a nest in the territory of another pair (No. 3) but was repeatedly attacked. Changing sites after a successful nest occurred on four occasions by four pairs; two of these nests again gave rise to fledgelings. Renesting at the same site after an earlier success occurred 12 times, by 11 pairs; six of these were again successful.

Both sexes build the nest. Time spent building varied with site, date, stage at which previous nesting (if any) ended and individual pair. For first nests of the season pairs averaged seven days between start of building and laying of first eggs; a few pairs required twice as much time. Building required less time as the season advanced, when a site was re-used and when the previous nesting ended at the egg stage rather than the nestling or fledgeling stage. Sengupta (1968) found the building period to be six to eight days for 20 nests in India, and Eddinger (1967) reported five to 12 days for 25 nests in Hawaii. Additional material is brought to the nest during laying and incubating.

Mynas use a variety of natural and manufactured products in nests: dry grass, eucalyptus leaves, small twigs, string, pieces of plastic and paper and primary and secondary feathers. Sengupta (1968) found snake sloughs in 10 of 20 nests in West Bengal and believed they were used to scare away predators. The nest has no lining and is solely a mass of unarranged material with a depression in the centre.

Figure 2 summarizes reproductive activities of 53 pairs. At least 108 nests were started. During November all building involved first nests of the season, and, except for five or six first nests in December, remaining building involved second and replacement nests. Intervals between peaks in numbers of pairs constructing nests became gradually shorter as the season advanced.

2. Laying and Incubating —

Females in aviaries laid eggs between 0700 and 0900 on consecutive days. Average size of clutches was 3.9 for eight clutches, and number of eggs per clutch varied from three (two clutches) to five (one clutch) with four eggs most common (five clutches). All four nests in the field accessible to me had clutches of three. Average clutch sizes were 3.5 eggs for 10 nests in Honolulu (Eddinger 1967), 3.8 eggs for 12 nests in West Bengal (Sengupta -968) and 4.4 eggs

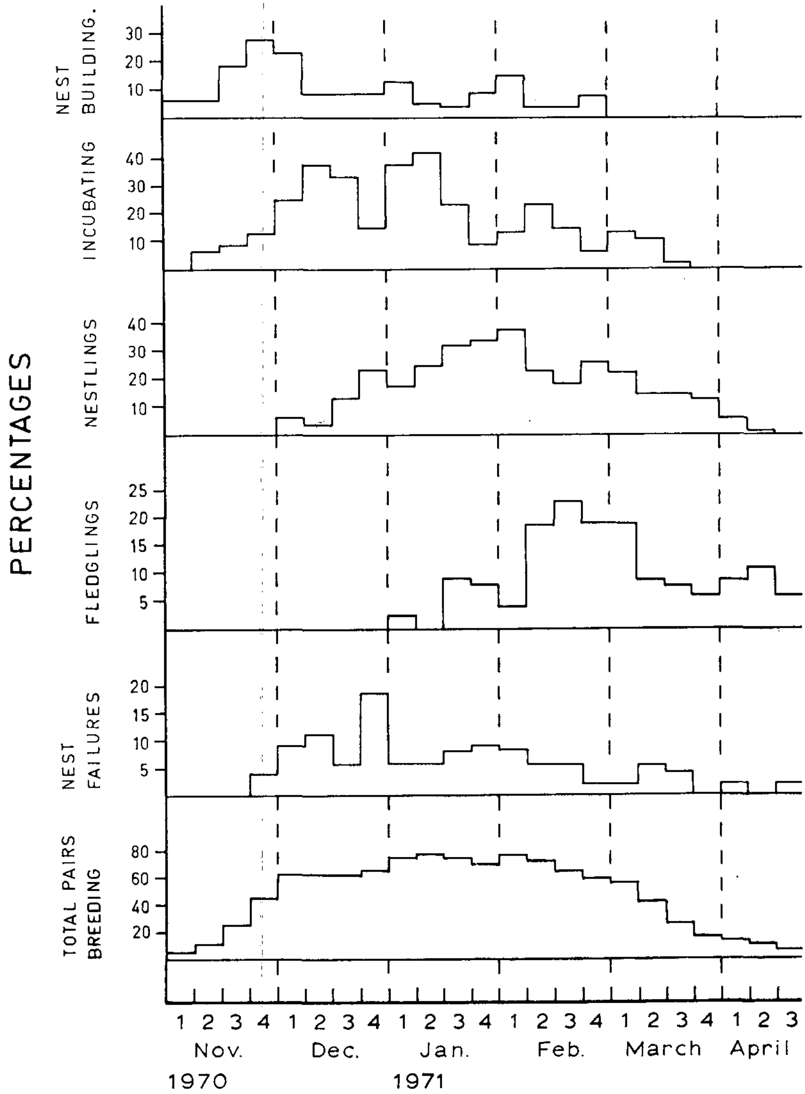

FIGURE 2 — Percentages of 53 pairs engaged in reproductive activities in study area during 1970-1971 breeding season.

for 20 nests in Madras State, India (Lamba 1963). At Havelock North, New Zealand, first clutches laid by inexperienced and experienced pairs averaged 3.5 and 4.1 eggs, respectively (Wilson 1973). Lamba (1963) believes the Myna to be an indeterminate layer because of geographical differences in sizes of clutches in India. However, in aviaries eggs broken during laying are not replaced, and this is characteristic of determinate layers (Davis 1955). Probably most songbirds are determinate layers (von Haartman 1971).

Incubation has been reported as beginning with laying of the second egg (Sengupta 1968) and with laying of the last egg (Eddinger 1967). Although aviary birds began sitting immediately after the second egg was laid, all eggs usually hatched on the same day. First eggs averaged 16 days between laying and hatching, while last eggs averaged 13 days. A similar period for incubating the last egg was found in Hawaii (Eddinger 1967). Only 14 days was required for first eggs of most clutches found near Calcutta (Sengupta 1968), though usually 17 days was necessary at Vellore (Lamba 1963), also in India.

Only the female possesses a brood patch and sits on the nest at night. Males sit on eggs for short periods during the day but undoubtedly do not warm them as efficiently as females (see Snow 1958: 98). Females in aviaries spent an estimated 30% to 40% of the day incubating, with an average of nine minutes per sitting period. Males made fewer visits than females and spent an average of four minutes per visit. In the field males and females together made an average of 4.7 visits per hour to nests with eggs, during 23 hours of observations.

There were four well-defined peaks in numbers of pairs with eggs that followed by one week each of four peaks in numbers of pairs building nests (Fig. 2). In total, 47 different pairs had 88 nestings to at least incubation, a mean of 1.66 nestings per pair for 53 pairs.

3. Nestlings —

In four clutches in the aviaries all eggs hatched on the same day, but one clutch hatched over three days; two clutches did not hatch and one clutch had one nestling. Only 48% of 31 eggs hatched. Chicks began begging immediately, and both parents fed them. In the aviaries parents fed nestlings live or dead insects but did not feed them food provided for adults (chicken mash, apples and minced meat). In the field nestlings were fed exclusively on invertebrates, primarily insects, for their first 10 days, after which time they were also fed small quantities of bread and fruit. Cicadas were common in the study area from late December to March, and during February they constituted up to 90% of items brought to some nests with nestlings two weeks or older. Females brood at night for 14 to 17 days before joining males at communal roosts. In the field pairs made an average of 11 visits per hour to nests with nestlings, during 33 hours of observations.

During incubation there were 24 complete failures of nests, and as a result only 44 different pairs made 64 nestings to the nestling stage. The peak in numbers of pairs with nestlings occurred in late January and early February (Fig. 2).

4. Fledgelings and Nesting Success —

The nestling period varied from 20 to 30 days with an average of about 27 days. In the four cases of a brood fledging at three weeks of age, the young disappeared after one night out of the nest, presumably victims of predators or exposure; none could fly. During the day parents remain near fledgelings that can not fly, but families with flying young move toward the nearest trees. Families appear at communal roosts, but it is not known how soon this follows fledging. In January and February fledgelings from a first brood associate with parents for one to two weeks before being chased out of the territory; but, in March and April adults rarely attempt to re-nest if they already have fledgelings, and families may remain together for three or four weeks.

There were 24 complete failures of nests during the nestling stage, the same number as during incubation. In all, 55% of occupied nests did not produce fledgelings. Rate of complete failures was relatively constant throughout the nesting season except for one high, isolated peak in late December that corresponded to a sharp drop in numbers of nests containing eggs (Fig. 2). The reason for this peak is not known.

In total, 32 different pairs (60% of the pairs) produced 40 fledged broods, 24 single and eight double broods, resulting in 77 fledgelings. This is an average of 1.45 fledgelings per breeding pair — assuming that late-comers and early deserters to the study area did not breed successfully elsewhere. But, at its peak in March the number of fledgelings and juveniles arriving at the Parnell roost was 32% of the total number of roosting birds (see Line C of Figure 3, Counsilman in press). Thus, recruitment in and around the study area by the end of the breeding season was probably slightly less than one young bird per two birds one year or older.

Based on an average of 3.9 eggs per clutch (aviaries), 88 nestings to incubation and 77 fledgelings nesting success in the study area was about 22% for 343 eggs. This represents a maxmium figure for success of eggs because probably not all nests were found before they failed (see Mayfield 1961), and not included are nests in which eggs may have been laid but incubation did not follow.

The 13 pairs that were present in the study area both before and after the 1970-71 breeding season had a nesting success of 27% for that season compared with 20% for other pairs; this difference was statistically significant ($P < 0.001$). Nesting success in the woodland subhabitat was not significantly ($P > 0.05$) different from success in the subhabitat with a moderate density of buildings and pavement.

5. Double Broods —

Two broods of fledgelings were produced by each of eight pairs: Nos. 2, 10, 16, 27, 28, 34, 38 and 46. These pairs had significantly ($P < 0.025$) fewer fledgelings per brood in their first brood (1.3) than in their second (2.3) and significantly ($P < 0.05$) fewer in their first brood than did pairs with only one brood (2.0). But, their second broods were significantly ($P < 0.05$) larger than those of single brooded pairs. Also, they had significantly ($P < 0.01$) fewer complete failures than pairs with no fledgelings but not significantly ($P > 0.10$) fewer than pairs with one brood; and, their first broods fledged significantly ($P < 0.01$) earlier than broods of other pairs.

One territory (No. 2) was in savannah, one (No. 10) was in grassland, and the remaining six were in areas with a moderate density of buildings and pavement. These territories were not significantly ($P > 0.05$) different in size from those of less successful pairs, but they did average 0.12 ha. smaller. Also, the coefficient of variation (S.D. $\div \bar{x}$) was 16% for sizes of territories of pairs with two broods but 30% for sizes of territories of pairs with one brood and 32% for territories of pairs with no young. In other words, there was a most favourable size for a territory and those belonging to the most successful pairs varied least from this size.

DISCUSSION

Urban birds are not isolated from conspecifics in natural habitats, and, consequently, speciation of populations in cities does not occur (Erz 1966). Thus, factors that have favoured the Myna for association with man are pre-adaptations evolved in another habitat, open woodland. Woodland and urban habitats are comparable in several respects: both have vertical structures (trees or buildings) suitable for nests, roosts and shelters widely spaced over ground with short or no cover of vegetation. Similarity of these two habitats is probably the primary factor that allows Mynas to exploit the urban environment. Ali & Futehally (1967: 87) suggest that a social disposition and omnivorous feeding habits favour the Myna for commensalism with man. Communal sleeping is, in part, an adaptation for avoidance of predators (Counsilman 1974, see also Gadgil 1972), and ground predators (*e.g.* rats, cats, mice, dogs and men) are more common in cities than in rural areas (for New Zealand see Kikkawa 1966). During the day, however, Mynas in cities appear to be less social than Mynas in rural areas, and sociality *per se* is not a prerequisite for urban dwelling (*e.g.* Blackbirds). A large proportion of urban species feed on a mixed diet (Winterbottom 1960 and 1966), and omnivorous feeding is perhaps the second most important pre-adaptation of Mynas for living in cities. It allows birds, except nestlings younger than 10 days, to eat a wide variety of foods besides those in their natural diet, and these foods are likely to be less seasonal in abundance than insects, fruits or seeds. Nesting in holes is probably an advantage, but not a necessity (*e.g.* Pigeons), for urban living because holes are safer from predators and weather (Nice 1957) and more abundant in cities than good sites for open nests. The three most common species in Auckland, House Sparrows, Starlings and Mynas, all nest in holes or crevices.

Possession of a territory and home range apparently confers a number of benefits. Both areas may help maintain pair bonds by isolating pairs during the day. Also, three of four copulations I saw in the field were interrupted or nearly so by other pairs; still, interference with copulations or nesting activities is likely to be less within than outside a defended area (Nice 1941). The significance of interference, however, is not known (Snow 1956). In most cases the territory provided a large proportion of food for adults, nestlings and fledgelings, but in a few cases, where disturbances were numerous, territories (especially Nos. 14 and 44) provided little food although the area defended was large. A home range probably provides a familiar area for feeding during winter and ensures a good area for breeding. Pairs that were present in the study area both before and after the 1970-71 breeding season produced significantly more fledgelings than other pairs. Also, waking and roosting times at the Parnell roost indicated that birds remaining in the city during winter were not pressed for time for foraging (Counsilman 1974; *cf.* Kluijver 1950: 111). Likewise, populations of House Sparrows (Summers-Smith 1963) and Blackbirds (Snow 1958) in suburban habitats did not experience shortages of food during winter.

Sengupta (1968) reports an average size for 12 territories of Mynas in India as 0.012 ha., which is 1.4% of the mean size of 51 territories in Auckland — far too small to provide much food or isolate pairs. Bertram (1970) found intense competition for holes in trees among Indian Hill Mynahs *(Gracula religiosa)*, Indian Mynas and other species. Because of their smaller body size in India and the richer avifauna there Mynas must compete with many more species than in New Zealand to obtain and retain a nest-site. Such competition usually leads to the evolution of defence of a nest area and not defence of a food and nest territory (von Haartman 1957).

Although the urban environment is generally considered to be rich in food for birds (Erz 1966, Snow 1958 & Summers-Smith 1963), nesting success of Mynas was 14% in Honolulu (Eddinger 1967) and 22% in Auckland but 61% (Lamba 1963) and 76% (Sengupta 1968) in two non-urban areas in India and 33% in a non-urban area in New Zealand (Wilson 1973). The importance of predation in Auckland is not known, but it would be expected, like weather, to lead to complete rather than partial failures of nests (Nolan 1963, Ricklefs 1969). A 55% rate of complete failures of nests of Mynas is similar to rates found for Blackbirds and Song Thrushes *(Turdus philomelos)* in Dunedin, New Zealand, where predation accounts for about half of all nest losses (Kikkawa 1966). But, Blackbirds and Song Thrushes nest in the open. In England, predation on nests of Blackbirds (Snow 1958) and Robins (Lack 1943) was high in wooded areas but not in gardens. Shortages of food, on the other hand, result in both complete and partial failures of nests, and probably most nests in the study area had at least one death of eggs or nestlings.

Starvation of nestlings has been suggested as a major cause of mortality in nests of the Myna by Eddinger (1967), Lamba (1963), Sengupta (1968) and Wilson (1973). Bertram (1970) believes that, in the absence of man, reproduction by the Indian Hill Mynah is limited by abundance of food for nestlings and availability of sites for nests. Sites for nests are not in short supply in Auckland. And, the same number of complete failures of nests during incubation as during brooding indicates that a shortage of food for nestlings is not the only cause of mortality in nests in Auckland. Adult Mynas in urban areas, like adults of House Sparrows (Summers-Smith 1963) and Blackbirds (Snow 1958), may also experience a shortage of food during the breeding season. In India, incubating (Lamba 1963, Whistler 1949) and probably also brooding are largely performed by the sun, but in New Zealand this is not possible, at least to the same extent. Thus, pairs with occupied nests in New Zealand must either spend less time foraging or incubate and broods less efficiently than pairs in India. Disturbances may indirectly accentuate shortages of food by interfering with foraging and, as in aviaries, may directly cause some infertility, deaths of embryos and nestlings and desertions of nests. In Honolulu, 25% of 56 eggs did not hatch (Eddinger 1967); an average of about 12% appears normal for passerines in non-urban habitats (see Ricklefs 1969: 4). Heavy infestations of mites on nestlings have been found in Auckland, Hawke's Bay, New Zealand (Wilson 1973) and Hawaii (Eddinger 1967) and are likely to contribute to mortality in nests when food for nestlings is scarce. Only 13% of the 48 complete failures of nests are known to be the result of weather, a small entrance to the nest-site and destruction by man.

In England, Robins (Lack 1943), House Sparrows (Summers-Smith 1963) and Blackbirds (Snow 1958) have smaller clutches and higher densities in gardens than woods. Likewise, clutches of Mynas in Auckland and Honolulu averaged smaller than clutches in non-urban habitats in India and New Zealand. And, although possibly the highest densities of Mynas in New Zealand occur in fruit growing districts, Mynas certainly are not as numerous in other cultivated areas as in cities. Finally, Erz (1966) suggests that higher temperatures in cities favour longer breeding seasons than found in natural habitats. The 1970-71 season in Auckland was indeed longer than the same season in Hawke's Bay (Wilson 1973).

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