

CHAPTER III**URBAN BIRDS: THEIR FEEDING GUILDS AND ROOSTING NICHES****INTRODUCTION**

Food and shelter are the two basic necessities for all the living organisms which they get from their habitats. It is a long established fact that availability of food affects the population size (Perrins and Birkhead, 1983; Krebs, 1985; Welty and Baptista, 1988). Andrewartha and Birch (1954) have discussed that animal's chances for survival and to multiply depend on four components of the environment such as the weather, availability of food, predators and secured shelter. The number of animals in a natural population is affected in three ways: first, by the limited supply of material resources, like food and places for building nests by inaccessibility of the material resources related to the animal's capacities for dispersal and searching, besides the shortage of time when the rate of increase is positive. For many species, food is the most important ultimate factor while for some species other resources like breeding sites, nesting materials, rain, day length *etc.* play important role for survival and breeding (Lake, 1968; Immelmann, 1971).

In developing world, increase in human population has led to the fragmentation of habitat and decrease in the availability of natural resources. As the human pressure increases it modifies the habitat with change in its vegetation structure and availability of unpredictable anthropogenic food. These changes are reported to influence the urban bird communities (Mills *et al.*, 1989). Several species of birds adapt to these modified habitats while others leave the habitat

and become extinct in that area. It is also reported that the vegetation structure is highly developed and diversified at the edges of urban areas influencing the bird diversity (Smith and Schaefer, 1992). Birds are the biological indicators that are studied extensively to find out influence of habitat change. The changes in the bird communities occur across the gradients of urbanization (Clergeau *et al.*, 1998). According to the difference in feeding habits, different species of birds are expected to respond in different ways. The immediate response of birds to any changes in environment can be due to their specific type of feeding, nesting and roosting habits. As they are able to fly away from any adverse condition, their presence in a particular area can be associated with their dietary guilds, their type of habitat as well as human disturbances.

The relation between human and bird communities is easy to study (Cody, 1985). Reynaud and Thioulouse (2000) have stated that the bird data can reflect habitat changes and the data analysis can identify the most important factors that cause changes in the bird population and bird species or it can also identified the guilds that are more suitable to represent these changes. It seems that the study of guilds is less time-consuming than that of species. The analysis of the avian response to guilds indicates those species that are most sensitive to habitat perturbations and species that are benefited or at least are not affected by environmental disturbances.

In the present chapter, birds observed in 12 different areas- *i.e.* nine terrestrial habitats (DA, MD and UD, Chapter I) along with three ponds (LP, GP and HP, Chapter II) are divided in to 7 different categories on the basis of their feeding guilds as described by Ali (1996). These categories are **Graminivores**: The

species that feed on seeds as well as grass. **Omnivores:** species eating insects and small animals as well as fruits and seeds. **Carnivores:** Generally feeding on fish, frog, snake, insects and worms. **Insectivores:** exclusively depending on insects. **Frugivores:** feeding exclusively on fruits. **Birds of prey:** the hunters feeding on animal matters and **Nectarivores:** nectar feeders. Their density and abundance in 12 different study areas are analyzed to understand. The feeding guilds available in Vadodara city.

The second important factor that gets modified due to urban development is shelter. In urban area the native vegetation is replaced by ornamental vegetation or concrete jungle. As discussed in Chapter I and II, larger number of urban exploiters, moderate number of urban adaptors and several native species are found in Vadodara city. Many of these use concrete structure or modified vegetation as their roosts besides others use these habitats for nesting. Several species of birds especially urban exploiter roost in large colonies in Vadodara. Hence, the densities of birds at some of the roosts in the city needed evaluation.

MATERIALS AND METHODS:

As mentioned earlier depending on the feeding habits, birds were categorized in to seven different guilds: Graminivores, Omnivores, Insectivores, Frugivores, Carnivores, Birds of prey and Nectarivores depending on the description given by Ali (1996). Further, the number of species with their densities in each group were pooled to find out densities of each groups in the city. To find out their abundance (%) (Krebs, 1985), the data for 12 sites was pooled for each group every month. These monthly data of % abundance of

each group was used to find out annual total monthly density and further analyzed using ANOVA or t-test for different study areas as DA, MD and DA (Chapter I and II) with the help of Graph-pad Prism-3 and Excel.

To find out the roosting sites of birds, the study areas as well as different places of Vadodara city were visited during evening hours. A bird count using block count method (Rodgers, 1991) was carried out for the species observed when birds started arriving at the roost. Mean values of the number of some species like Parakeet, Common Myna, Rosy Starling, Crows and Kites were considered as total number of these species at different roosting sites.

The p value for ANOVA and t-test is non significant if $P > 0.05$ (ns), significant if $P < 0.05$ (*), significantly significant (**) if P is < 0.001 and highly significant (***) if $p < 0.0001$. The positive and negative impacts of urban pressures on avifauna are discussed.

RESULTS

Density and abundance of birds according to their feeding habits

Graminivorous birds: 6 species of graminivorous birds Rock Pigeon (*Columba livia*), Eurasian collared Dove (*Streptopelia decaocto*), Spotted Dove (*Streptopelia chinensis*), Laughing Dove (*Streptopelia senegalensis*), Indian Silver bill (*Lonchura malabarica*) and Scaly-breasted Munia (*Lonchura punctulata*) (Fig. 3.1, Table 3.1) were found during the study period. The graminivore species are the major group with 48.91 ± 1.02 % abundance and 2080 ± 65.23 birds/Km² total density in Vadodara (Fig 3.2, Table 3.1). Highest density of graminivores was noted at RCDR (9714 ± 669.6 birds/Km²) followed by CA (3738 ± 264.4 birds/Km²), IA (3525 ± 261.8 birds/Km²), GP (2072 ± 200.3 birds/Km²), SG (1429 ± 119.0 birds/Km²), AG (1360 ± 86.54 birds/Km²), LP (1119 ± 191.1 birds/Km²), UC (812.9 ± 46.85 birds/Km²), MF (377.7 ± 40.81 birds/Km²), RA (339.8 ± 33.82 birds/Km²), HP (286.7 ± 45.77 birds/Km²) and lowest at PTCC (182.9 ± 28.55 birds/Km²) (Fig 3.1). The differences were highly significant among each group, DA ($P < 0.0001$, $F_{2, 69}$ 63.10), MD ($P < 0.0001$, $F_{3, 92}$ 41.80), UD ($P < 0.0001$) and PS ($P < 0.0001$, $F_{2, 69}$ 30.42)

Omnivorous birds: The next major group was of omnivore species that include 32 species observed in 12 areas. The highest density of omnivorous birds were noted at GP (2822 ± 197.2 birds/Km²) followed by LP (2721 ± 197.2 birds/Km²), SG (1652 ± 96.37 birds/Km²), CA (1104 ± 57.79 birds/Km²), UC (1078 ± 51.0 birds/Km²), IA (972.5 ± 56.34 birds/Km²), HP (900.8 ± 124.4 birds/Km²), AG (611.1 ± 64.64 birds/Km²), RCDR (381.1 ± 32.40

birds/Km²), PTCC (266.7 ± 17.53 birds/Km²), RA (200.0 ± 12.78 birds/Km²) and lowest at MF (189.4 ± 14.05 birds/Km²) (Fig. 3.1). Highly significant differences were noted among DA ($P < 0.0001$, $F_{2, 69} 59.11$), MD ($P < 0.0001$, $F_{3, 92} 96.09$) and PS ($P < 0.0001$, $F_{2, 69} 40.23$) but insignificant ($P > 0.05$) among UD. The abundance of the omnivorous birds was 25.3 ± 0.69 % and the total density was 1072 ± 33.63 birds/Km² (Fig 3.1, Table 3.1).

Next in abundance were **Carnivores** species with 10.04 ± 0.73 % abundance and 429.1 ± 34.25 birds/Km² total density (Fig 3.2, Table 3.1). This includes 17 species of birds feeding on animal matter. Their highest density was noted at HP (1683 ± 206.8 birds/Km²), followed by LP (1219 ± 323.4 birds/Km²), GP (976.7 ± 121.1 birds/Km²), SG (639.0 ± 110.4 birds/Km²), CA (230.8 ± 124.1 birds/Km²), UC (89.05 ± 12.87 birds/Km²), PTCC (76.46 ± 13.37 birds/Km²), MF (75.24 ± 8.18 birds/Km²), RCDR (50.0 ± 34.33 birds/Km²), IA (48.33 ± 7.41 birds/Km²), AG (38.89 ± 10.02 birds/Km²) and RA (23.75 ± 10.02 birds/Km²) (Fig. 3.1). Highly significant differences were noted among the MD ($P < 0.0001$, $F_{3, 92} 27.81$) but insignificant among each group ($P > 0.05$) of DA, UD and PS.

Insectivorous birds: Total 28 species of insectivorous birds were noted in 12 study areas with 6.67 ± 0.96 % total abundance and 291.8 ± 46.37 birds/Km² total density (Fig. 3.2, Table 3.1). The highest density of insectivorous birds was 1598 ± 531.2 birds/Km² at CA, followed by 457.8 ± 190.9 birds/Km² at GP, 287.8 ± 46.08 birds/Km² at AG, 257.6 ± 35.71 birds/Km² at UC, 234.4 ± 30.50 birds/Km² at LP, 135.8 ± 14.74 birds/Km² at IA, 122.2 ± 45.74 birds/Km² at RCDR, 114.2 ± 32.85 birds/Km² at HP, 97.26 ± 46.94 birds/Km²

at MF, 90.48 ± 14.56 birds/Km² at SG, 53.96 ± 9.13 birds/Km² at RA and 52.08 ± 5.37 birds/Km² at PTCC (Fig. 3.1). Significantly significant differences were noted among DA ($P < 0.001$, $F_{2, 69} 7.579$), highly significant among MD ($P < 0.0001$, $F_{3, 92} 14.92$) and insignificant among both UD ($P > 0.05$) and PS ($P > 0.05$, $F_{2, 69} 2.371$).

Three species of **Frugivorous birds** were observed in Vadodara during the study period with 5.88 ± 0.32 % abundance and 248.1 ± 13.19 birds/Km² density (Fig. 3.2 and Table 3.1). The density of frugivores was high at SG (564.8 ± 52.14 birds/Km²), followed by LP (451.1 ± 34.68 birds/Km²), UC (449.0 ± 31.40 birds/Km²), AG (411.1 ± 97.29 birds/Km²), RCDR (215.6 ± 37.78 birds/Km²), IA (178.3 ± 21.70 birds/Km²), MF (161.7 ± 47.99 birds/Km²), CA (155.0 ± 29.84 birds/Km²), RA (148.3 ± 24.46 birds/Km²), GP (134.4 ± 47.4 birds/Km²), PTCC (66.04 ± 9.95 birds/Km²) and low at HP (41.67 ± 13.35 birds/Km²) (Fig. 3.1). Highly significant differences were noted among MD ($P < 0.0001$, $F_{3, 92} 8.990$) and PS ($P < 0.0001$, $F_{2, 69} 38.10$) and insignificant among DA ($P > 0.05$, $F_{2, 69} 1.004$) and UD ($P > 0.05$).

Only 2 species of diurnal **Birds of prey** were observed during study period. These are Black Kite (*Milvus migrans*) and Shikra (*Accipiter badius*). The total density of birds of prey was 27.10 ± 2.318 birds/Km² and the abundance only 0.64 ± 0.05 % (Fig 3.2, Table 3.1). The highest density of birds of prey was 70.95 ± 11.99 birds/Km² at SG followed by 50.83 ± 12.45 birds/Km² at CA, 36.67 ± 16.23 birds/Km² at IA, 36.19 ± 5.57 birds/Km² at UC, 31.11 ± 4.72 birds/Km² at AG, 25.56 ± 5.43 birds/Km² at RCDR, 23.33 ± 5.85 birds/Km² at LP, 18.33 ± 7.97 birds/Km² at HP, 12.5 ± 2.04 birds/Km² at RA, 8.33 ± 1.01

birds/Km² at MF, 5.83 ± 1.49 birds/Km² at PTCC and 5.55 ± 2.25 birds/Km² at GP (Fig 3.1). Highly significant differences were noted among MD ($P < 0.0001$, $F_{3, 92} 11.83$) and insignificant among DA ($P > 0.05$, $F_{2, 69} 1.075$), UD ($P > 0.05$) and PS ($P > 0.05$, $F_{2, 69} 2.447$).

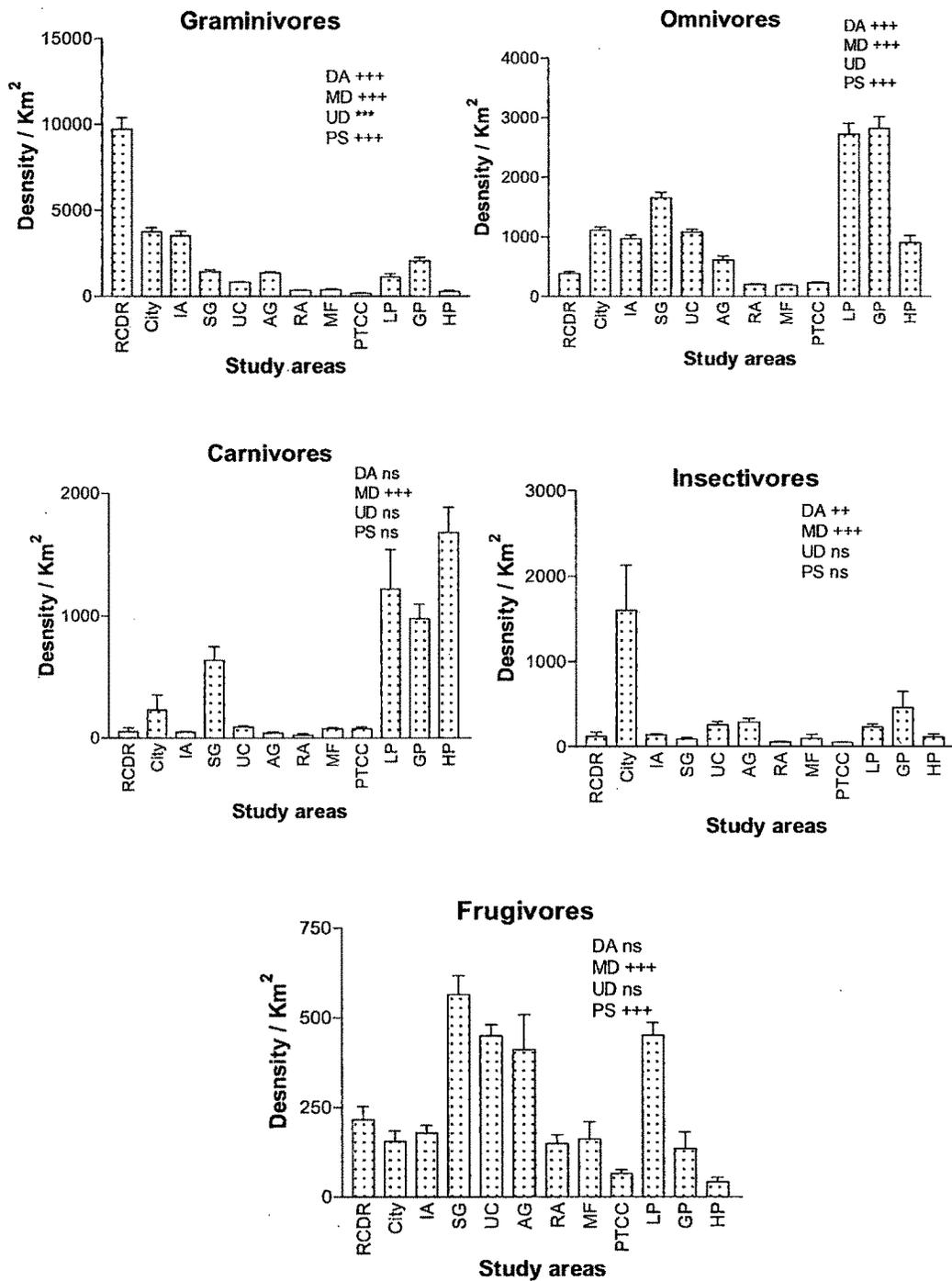
Though several species feed on nectar, only 2 purely **nectarivorous** species Purple-rumped Sunbird (*Nectarinia zeylonica*) and Purple Sunbird (*Nectarinia asiatica*) were observed in Vadodara. They were not observed in CA. Their abundance was $0.62 \pm 0.06\%$ and the total density 26.77 ± 2.70 birds/km² (Fig 3.2, Table 3.1). Their highest density was 74.44 ± 11.0 birds/Km² at LP followed by 67.50 ± 10.62 birds/Km² at IA, 54.44 ± 6.9 birds/Km² at AG, 42.38 ± 6.68 birds/Km² at UC, 24.44 ± 6.19 birds/Km² at GP, 16.04 ± 2.10 birds/Km² at PTCC, 16.04 ± 2.55 birds/Km² at RA, 14.76 ± 3.54 birds/Km² at SG, 6.66 ± 2.40 birds/Km² at RCDR, 3.69 ± 0.96 birds/Km² at MF and 0.83 ± 0.83 birds/Km² at HP (Fig 3.1). Highly significant differences were noted among areas of each group DA ($P < 0.0001$, $F_{2, 69} 35.01$), MD ($P < 0.0001$, $F_{3, 92} 13.93$), UD ($P < 0.0001$) and PS ($P < 0.0001$, $F_{2, 69} 26.46$).

Roosting birds:

Number of individuals at roosts were counted for those species that roost together in large number. Table 3.2 gives the roosting population of few species in Vadodara. Rosy starling (*Sturnus roseus*) is a migratory species that gather in huge number before spring migration (January to April). Three roosts of Rosy starling were found in Vadodara city during the study period. One on the trees around T. B. Hospital (TBH) in the western part of the city, second near Lal baug Pond (LP), on the trees of Railway staff colony (RSC) and third

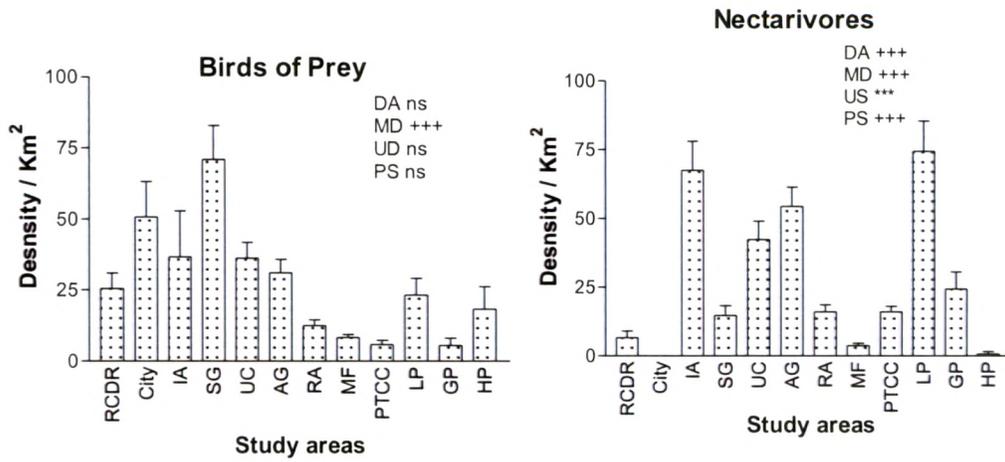
on the trees around Bahucharaji Smashan (BS) (Table 3.2). The roost at the T. B. hospital was largest with about 40000 ± 12180 individuals, followed by BS with 21960 ± 8359 individuals and RSC with 1767 ± 696 individuals. The roosts of Common Myna were also observed at TBH (50 ± 50), BS (228.6 ± 35.93), RSC (416.7 ± 30.73) and also on the trees around Food and Drug Laboratory Campus (FDLC) (295 ± 8.66). The roosts of Crows were noted at TBH (180 ± 30), BS (181.4 ± 41.54) and RSC (416.7 ± 30.73) while a single roost of Parakeet was present near Railway station (RS) where about 17000 ± 500 individuals were counted. Roots of Black kite had 115.7 ± 6.11 individuals near Railway station, 100.0 ± 3.78 at SG and 156.4 ± 8.1 in Bhootdi Jhapa area.

Fig 3.1 Distribution of Density of birds according to their different feeding habits at different study areas of Vadodara City.



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DA = Disturbed areas, MD = Moderately Disturbed areas, UD = Undisturbed areas, PS = Ponds
 */ + P < 0.05, ** / ++ P < 0.001, *** / +++ P < 0.0001, ns = insignificant
 *For T-test, + For ANOVA

Fig 3.2 Percentage distribution of birds according to their feeding habits in Vadodara city.

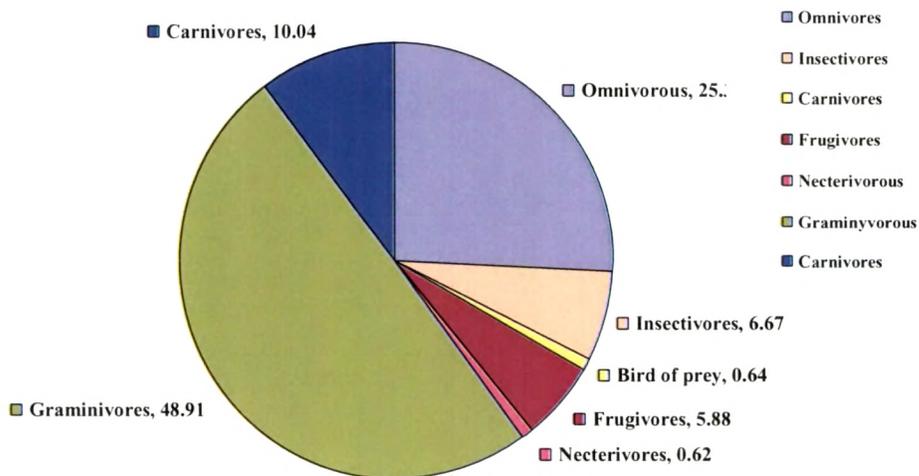


Table 3.1 Total number of Species, percentile distribution and density of birds according to their feeding habits in Vadodara city.

Feeding Guilds	Total number of species	Species abundance (%)	Density/Km ²
Graminivores	6	48.91 ± 1.02	2080 ± 65.23
Omnivores	32	25.30 ± 0.69	1072 ± 33.63
Carnivores	17	10.04 ± 0.73	429.1 ± 34.25
Insectivores	28	6.67 ± 0.96	291.8 ± 46.3
Frugivores	3	5.88 ± 0.32	248.1 ± 13.19
Birds of Prey	2	0.64 ± 0.05	27.10 ± 2.318
Nectarivores	2	0.62 ± 0.06	26.77 ± 2.70

Table 3.2 Number of birds at different roosting places.

Species	TBH	RS	BS	RSC	FDLC	SG	BJ
Parakeets		17,000 ± 500 (n = 2)					
Common Myna	50 ± 50 (n = 5)		228.6 ± 35.95 (n = 7)	416.7 ± 30.73 (n = 7)	295 ± 8.66 (n = 3)		
Black Kite		115.7 ± 6.11 (n = 5)				100.0 ± 3.78 (n = 5)	156.4 ± 8.1 (n = 22)
Crows	180 ± 30 (n = 5)		181.4 ± 41.54 (n = 7)	416.7 ± 30.73 (n = 7)			
Rosy Starling	40,000 ± 12,180 (n = 5)		21,960 ± 8359 (n = 7)	1767 ± 696 (n = 7)			

TBH=T.B. Hospital, RS= Railway Station, BS= Bahucharaji Smashan, RSC = Railway Staff Colony, FDLC= Food and Drug Laboratory Campus, SG = Sayaji Garden, BJ = Bhootdi Jhapa.

DISCUSSION:

It is well known that food and roosting as well as nesting sites are the basic requirements for survival and continuation of a species of bird (Welty and Baptista, 1988). As a result of urbanization, a new ecosystem urban ecosystem has developed that is a modified ecosystem with moderate to heavy concrete jungle. Certain birds adapt to these modifications very well but many leave the site. In the present study, it is noted that Vadodara mainly offers the graminivorous guild to birds. Maximum number of granivores, the Blue Rock Pigeon (*Columba livia*) are found in the city. The birds like pigeons, usually congregate around temples, mosques and other large buildings including railway stations (Ali and Ripley, 1969) where they are fed with grains.

The highest density of **gramnivores** noted at RCDR, the commercially disturbed area, may be correlated to the several pigeon feeding spots on the busy road (Plate XVIII). Freely available supplementary foods which are exploited by urban dwelling species have several readily predictable outcomes (Boal and Mannan 1999). Most important and significant of this is advancement of breeding dates by seasonally breeding birds as they may rear additional brood when food is unusually abundant (Perrins and Birkhead 1983). In Vadodara, extended breeding period for pigeon has been reported by Kotak (1979). Simultaneously the concrete buildings provide secured roosting as well as nesting places ultimately resulting in increased population of pigeon. Thus, in Vadodara the total density of graminivorous birds is rather high.

The next abundant population of graminivores was noted at CA the second disturbed commercial area but with residential buildings of heritage pattern. This again provides nesting sites and easy food in the form of feeding spots. Thus, the two most disturbed areas in the city have maximum density of graminivores. Interestingly, at undisturbed areas, MF and PTCC, the graminivorous species were minimum as in these habitats human movements and concrete structures are least hence no easy food supplies. In model farm, the main crops harvested are pigeon pea (*Cajanus cajan*), maize (*Zea mays*) and green grams (*Vigna radiate*) but they are not easily consumed by birds. However, occasionally the density of pigeon feeding on them was high. According to Beissinger and Osborne, (1982) the flocks of birds feeding on ground or lawn repeatedly find foraging patches and food items as these habitats being open, increase visibility that increases probability of detecting and escaping predators. At PTCC, the vegetation consists of large trees and grasses that are less favoured habitat by the graminivores. Lim and Sodhi (2004) have reported that graminivore abundance increases with increasing public housing as they provide more anthropogenic food due to littering, improper waste handling or deliberate feeding. In Vadodara, deliberate feeding is equally common with littering and improper waste handling, in disturbed and moderately disturbed areas.

The result shows that RCDR, supported maximum pigeon density. Here, many large trees like Neem (*Azadiracta indica*), Banyan (*Ficus benghalensis*), Ashoka (*Saraca indica*) and Gulmohar (*Delonix regia*) are present on one side of the road. These do not have effect on the density and also feeding and

nesting activities of pigeons. The majority of graminivores observed in Australian urban areas were ground foragers for whom the amount of vegetation available for roosting was insignificant as long as open space was adequate for foraging (Young *et al.*, 2007). In many areas of Vadodara, instead of trees, concrete structures provide suitable habitats and other needs such as roosts and shelters for pigeons. Among other areas, moderately disturbed areas as well as ponds, the areas with more anthropogenic activities like SG, UC, AG, LP and GP had higher pigeon densities and remaining areas RA and HP had very low pigeon densities.

In Rennes, France, the omnivorous species have been reported to adapt to the urban environment with its particular food resources like garbage (Cleargeau *et al.*, 1998) whereas in Southern hemisphere of Adelaide, urban areas of Australia are dominated by the assemblages of nectarivore birds that depend on the street trees that are flowering trees (Young *et al.*, 2007). However, in the present study, Vadodara, located in the semiarid region of Gujarat, India, Graminivores have dominated the urban landscape. In this land of Mahatma Gandhi, with many animal lovers and also followers of Jainism and Swaminarayan leadership, feeding pigeons (and cattle) is a very common practice that probably influenced pigeon population. The high density of graminivores is mainly due to pigeon densities as is also discussed in Chapter I and II.

The next important feeding guild used by birds in Vadodara is **omnivore** guild. The density of omnivores was high around two ponds LP and GP. Where the ponds have trees for roosting (LP) or garbage dump for feeding (GP) for the

species like Large-billed Crow and Common Mynas increasing their densities. This shows that Omnivorous species have adapted to the urban environment and its particular food resources such as garbage as is also reported by Clergeau *et al.* (1998). Further, LP with a garden also provides lawns for the species like Common Myna. The sub-urban lawns have higher net productivity and food utilization by birds than other grassland habitats and they act as areas of concentrated food supply capable of supporting high densities of birds (Falk, 1976). The densities of Crows and Common Myna directly affected the abundance of the omnivorous guild. This indicates that omnivorous birds are abundant in the areas that have water resources. These species are more tolerant towards human disturbances because omnivorous species do exploit anthropogenic food resources effectively (Jokimaki and Suhonen, 1998).

LP, GP and HP support **Carnivorous** guilds that mainly supply aquatic food like fish, molluscs, amphibians, *etc.* available in pond water. Therefore, the density of carnivores was higher at these three ponds. However, their abundance was low as compared to graminivorous as well as omnivorous birds.

Insectivorous birds were mainly available at CA, one of the most disturbed areas with minimum vegetation. The high density of insectivores at CA was due to House Swifts that nests in the old heritage type of buildings. The density of insectivores is probably higher in the area because of the garbage dumps that provide habitats for larvae of flying insects on which swifts feed. However, according to Lim and Sodhi (2004), the richness of insectivores and carnivores increase with increasing natural vegetation and declines with increasing percentage of built up area and human population. Compared to graminivorous

birds, the abundance of the insectivorous birds was low in Vadodara, as Insectivores are reported to be more sensitive to the quality of the environment (Clergeau *et al.*, 1998).

The **frugivorous** guild was available in moderately disturbed areas (UC, SG, AG, RA) as well as pond (LP) with the garden where large flowering and fruiting trees are present. The residential areas with backyard vegetation and the gardens or parks with large trees are favoured by the frugivorous birds (Reynaud and Thioulouse 2000). The frugivorous guild appeared mainly at low-density housing development of residential areas (Lim and Sodhi 2004). However, compared to other guilds the abundance of frugivore birds was low.

Only 2 species of diurnal **birds of prey** (raptors) are common in Vadodara. These are Black Kite (*Milvus migrans*) and Shikra (*Accipiter badius*). Of these two, large roosts of kites are present showing annual fluctuations (Rathod and Padate, 2004). The birds leave the roosts in the morning spreading in different areas of city. The density of raptors was due to the large number of Black Kite present in the city. Their high density was noted at SG, CA, UC and IA, the areas nearer to water either Vishwamitry river or Sursagar lake. These carnivores need water after their foods. Being top carnivore and because of transect time the density as well as the abundance of kites was low but at the roosting areas the density was high. In a preliminary study Kites have been reported to feed on poultry left over, mainly skin with feathers in Vadodara (Rathod and Padate, 2004). However, less disturbed areas are reported to provide rodents, chickens or reptiles to the raptors (Reynaud and Thioulouse 2000).

Though Vadodara is having several areas with green patches, Nectarivorous guild was the smallest guild. Nectarivores often use suburban gardens (Young *et al.*, 2007). Urban avifauna use street trees and the species of tree strongly influence its use by birds (Young *et al.*, 2007). The highest density of nectarivorous birds was noted at LP and IA and higher at UC and AG this indicated that these four areas have several flowering plants.

Roosts of the birds

All birds need undisturbed places to rest, both during the day and at night, to avoid predation or stress (Weller, 1999). Many species use communal roost to rest at night, where large numbers of individuals congregate. These aggregations of roosting individuals at night are presumed to reduce the costs of thermoregulation, risk of predation and increase the foraging efficiencies (Eiserer, 1984). According to Beauchamp (1999) the association between flocking activities and communal roost suggests that foraging efficiency may have been a driving force in the evolution of roosting in several species of birds. During present study in Vadodara, species of birds like crows, kites, mynas and rosy starlings have been observed to roost in aggregation on large trees like Neem (*Azadirachta indica*), Banyan (*Ficus benghalensis*), Ashoka (*Saraca indica*) etc.

Among these species of birds largest single roost is of Rose ringed parakeet that uses the congregation of trees behind the railway station (Chapter I). Rose ringed parakeet is considered as a pest to several agricultural crops (Dhindsa and Saini, 1994). As they feed on cash crop like sunflower and maize as well as fruits which are grown in acres and acres of land, there is never a limitation

of food source for this species. In addition, they nest in secured holes in trees and old building providing security, and hence increasing the survival rate of species. Such huge roosting aggregation of Rose ringed parakeets are also reported in neighbouring town of Vallabh Vidhayanagar where their population is estimated to be reaching 62,945 (Parasharya, 2005). Parakeets leave their roost in the morning flying kilometers away to their feeding grounds. According to Alerstam (1990) many species of birds fly several kilometers and reach to their feeding grounds to avoid the scarcity of food and also to avoid the unbearable coldness during winter. Birds or bird flocks which have been at favorable feeding localities return purposefully from these good food resources by evening to the roost. At roost they pass on the information to individuals which have been less successful in the search for food and they may 'tag on' and accompany the successful individuals in the morning. Thus communal roost may serve as an 'information centre'.

Next species which has been observed roosting in large flocks is Common myna. They generally preferred the Ashoka trees (*Saraca indica*). Some species have very specific requirements for rest sites, presumably based on genetic make up and social structure (Weller, 1999). Though common mynas do not roost in huge flocks like Rose ringed parakeet, four roosts scattered in all direction of Vadodara, and each with 200 to 400 individuals amounting to more than 1000 individuals were found in Vadodara. More roosts may be present in the city.

Black kite is also observed roosting in flocks. The present study shows annual fluctuations in number of individuals at roost as well shifting of roosts. The

number of Black Kite increases during pre-monsoon and monsoon and decreases during summer April-May (Padate, personal communication). According to Mahabal and Bastawade (1984) this difference can very well be because of two possibilities. The increase can be attributed to increase in the number during July-August to fledging of young or, probably arrival of some migratory birds on the onset of monsoon from south India. Contrarily to this the decline may be attributed to the decline in number due to breeding activities of Kites during October to March period, when one of the partners is nest guarding and not seen flying in the sky, and hence the decrease in the soaring population. The race *Milvus migrans govinda* is a common race of Kite in Gujarat Another race *Milvus migrans lineatus* is winter visitor to the coastal regions of Bhavnagar, Gujarat, (Dharmakumarsinhji, 1955) in Western India and is frequently confused with *Milvus migrans govinda*. Identification of the race with the fluctuation in population and shifting of roosting sites needs further investigation.

As discussed earlier (Chapter I and II) crows are the species of concerned whose population is believed to be declining in urban areas. In the present study three roosts of the Crows were observed around three water bodies. These areas have easy availability of food and large trees for roosts. According to Withey and Marzluff (2005) crows do not move randomly but they “hopscotch” across landscape. Such a “hopscotch” manner of movement may attract them to multiple centers of urbanization (Alberti *et al.*, 2001). Crows are not common in Vadodara these days, however they have been observed in few pockets. Withey and Marzluff (2005) have reported increase in population of

American crow (*Corvus brachyrhynchos*) across North America, often at high rates in urban areas. According to them American crows are not drawn into urban areas but movements of dispersal produce a net influx into the city because of greater reproductive success outside the city than in it. In the outskirts of Vadodara, crows have been frequently observed flying away from city centers during roosting time. Among three ponds GP have garbage dump and LP have large trees which provide the feeding grounds as well as roosting trees for crows. Dispersing crows probably take advantage of the increased opportunity to forage at a variety of anthropogenic food sources, whether landfills or refuse from urban and suburban businesses (Withey and Marzluff, 2005). Further, it has been reported that the crows have become common in the urban areas of Singapore (Peh, 2002). Crows use woods with large trees for nesting (Edwards, 1888). Large roosting population of crows is also present in the woods amidst the campus of Indian Institute of Science in Bengaluru, India (Personal observation). Hence, the association between woods, urban centers and crow population needs further investigations.

Several species of migratory birds especially diurnal migrants assemble in large number at communal roosts to spend the night in enormous throngs. Some of these like starlings use roost sites in city centers (Alerstam, 1990). In Vadodara, three such roosting sites of Rosy starling (*Sturnus roseus*) chirping and buzzing din competing with the noise of the traffic are observed. At day time small flocks of Rosy starlings may be seen feeding on nectar from flowers of silk cotton trees (*Bombax ceiba*, Plate XXI) or fruits of *Ficus benghalensis* and *Pithecolobium dulcei*. However, as the evening set, flocks move towards

communal roost. In Vadodara, Rosy starling are not seen in the city, during July-October period but with advancement of winter in December – January, they start arriving at roosts in small flocks, slowly increasing in number and reach to its maximum density in month of April. One roosting population of about 40,000 individuals, second of about 22,000 individuals and third small of about 2000 individuals have been observed in Vadodara, roosting on the big trees like Neem and Ashoka tree in 3 different areas of the city. They start their spring migration to breeding grounds on Full Moon day (according to Hindu calendar- “Chaitri Poonam”) falling in April-May period. The starlings also often use roost sites in city centers, where they perch in flocks in trees or on tall buildings, often in the mats of ivy on fronts of buildings (Alerstam, 1990).

CONCLUSION

The urban ecosystem in semi-arid zone of Gujarat, India supports mainly graminivorous guild followed by omnivorous guild whereas ponds provide the good habitat for the carnivorous birds. The insectivores, frugivores and nectarivores are probably adversely affected by the human disturbances and urban development in this region.

PLATE XVIII

Feeding Place of Pigeons (*Columba livia*)



Feeding Place of Rosy Starling



PLATE XIX

Roosting site of Rosy Starling

