Bird assemblages in natural and urbanized habitats along elevational gradient in Nainital district (western Himalaya) of Uttarakhand state, India

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Abstract The Indian subcontinent is amongst the biologically better known parts of the tropics and its bird fauna has been well documented. However, avian community composition and diversity along elevational gradients and amongst habitat types remains unclear in India. We attempted to estimate bird assemblages in terms of diversity, species composition, status and abundance in urban and forest habitats of Nainital district of Uttarakhand (350–2450 m asl; 29°N), Western Himalayas. We sampled different elevational gradients and to understand the effect of urbanization and season on avian community composition. Field studies were conducted during January 2005 to January 2007. Results indicated that the forest had more complex bird community structure in terms of higher species richness (14.35 vs 8.69), higher species diversity (Shannon’s index 4.00 vs 3.54), higher evenness (0.838 vs 0.811) and more rare species (17 vs 5) as compared to urban habitat. However, the abundance of 11 species was higher in urban habitats. Bird Species Richness (BSR) varied considerably among study areas (91 to 113 species), was highest (113 species) at mid elevation (1450–1700 m asl) and decreased (22 species) at high elevation (1900–2450 m asl). It seems that high BSR at mid altitudes is not caused by the presence of a group of mid altitude specialists but rather that there is an overlap in the distribution of low land and high elevation specialists at this altitude. BSR and Bird Species Diversity fluctuated across seasons but not habitat type [Current Zoology 57 (3): 318–329, 2011].

Keywords Avian biodiversity, Western Himalaya, Urbanization

India has approximately 1300 species of birds (Grimmett et al., 1998), constituting 13% of the world bird assembly and thus is an area of high avian diversity. However, information about avian distribution across different habitats and Himalayan elevational zones across the region is scarce, fragmented and preliminary (Ali and Ripley, 1998). Previous assessments of avian diversity have been confined mainly to south Indian forest (Price, 1979; Joshua and Singh, 1986; Pramod et al., 1997; Kante et al., 1999; Singh, 2000; Ramesh, 2001; Shankar and Joshi, 2001) and much of the Himalayan area remains unexplored (Chettri et al., 2001; Price et al., 2003; Sultana et al., 2007). Further, what we know about avian communities and dynamics is largely based on temperate areas. The need therefore arises to generate substantial data on avian community composition from tropical areas.

Comparative studies of avian community composition in different habitats, including urbanized areas, can improve our knowledge of the general patterns and processes that characterize bird species and communities. A number of studies that describe avian responses to urbanization (conducted mainly in temperate areas) suggest that urbanization affects landscape heterogeneity and consequently, the distribution, abundance and resources upon which birds depend (Beissinger and Osborne, 1982; Marzluff, 2001; Jokimaki et al., 2002; Blair, 2004; Chace and Walsh, 2004; Manhaes and Alan, 2005). Urbanization thus creates a complex environmental gradient from undisturbed natural areas to highly modified urban landscapes that can be useful in exploring relationships between environmental heterogeneity and the diversity and abundance of species (Matson, 1990; McDonnell and Pickett, 1990; McDonnell et al., 1993; Crooks et al., 2004).

However, almost all these studies have been conducted in temperate areas and studies from the regions of highest human population growth such as the southeast region of the world are missing. Recent studies comparing bird communities across rural-urban gradi-
ents found that both species richness and total avian abundance peaked at moderate levels of urban development in temperate areas (Blair, 1996, 2001; Mckinney and Lockwood, 2001) and the number of low nesting species and of species with multiple broods increased with urbanization (Blair, 2004). Several other studies have demonstrated increases in avian diversity at intermediate levels of urban development (Nourteva, 1971; Lancaster and Rees, 1979; Jokimaki and Suhonen, 1993). However, only a few studies have examined the effect of continual development on species composition and abundance. As urban development increases, bird communities become more distinct from the native community but more homogenous with other urban areas (Scott, 1993; Edgar and Kershaw, 1994; Blair, 2001; Chace and Walsh, 2004; Devistor et al., 2007). Unfortunately, across the Indian subcontinent, scant studies have compared bird assemblages in urban areas with natural forests.

Our goal was to better understand differences in avian community composition among natural and urban habitats, along elevational gradients and across seasons in Nainital district, Western Himalaya. This area is a recognized global biodiversity hotspot. At mid and high elevations, urbanized habitats were surrounded mainly by forests and hence a comparison was made between avian communities in forest and urban habitats at all elevational zones across our study area.

1 Materials and Methods

1.1 Study area

We chose different sections of forest and urban habitats across three study sites of Nainital district (Western Himalaya; 29°N 79°E): (A) Nainital (high elevation 1900–2450 m asl), (B) Bhowali (mid elevation 1450–1700 m asl) and (C) Haldwani (low elevation 350–500 m asl) along different elevational gradients (Fig. 1). Three urban and three forest sites across three elevational zones were surveyed.

Urban habitats included three towns: Nainital, (N 29°23′46.8″ E 79°26′51.1″; 1900–2033 m asl, area 11.7 km², population 38 560; 50–100 m distance between forest and town), Bhowali (N 29°23′03.7″ E 79°31′29.5″; 1610–1700 m asl; area 12.5 km², population 20 560; 500 m distance between forest and town) and Haldwani (N 29°12′43.9″ E 79°29′33.0″; 450–500 m asl; area 14.5 km², population 129140; 4–5 km. distance between forest and town). These towns include residential and commercial buildings, roads and other paved surfaces, ornamental trees such as Ficus palmata, F. auriculata, Hibiscus mutabilis, Nerium indicum and gardens. Bhowali appears to be moderately urbanized with a greater distance between houses and more vegetation types compared to the other towns. Forest habitat consisted of oaks Quercus leucotrichophora and deodar Cedrus deodara (Nainital; high elevation), oaks Quercus leucotrichophora and pines Pinus roxburghii mix (Bhowali; mid elevation) and sal Shorea robusta and khair Acacia catechu mix (Haldwani; low elevation) (Saxena and Singh, 1982; Singh and Singh, 1992).

Field studies were conducted over two years from January 2005 to 2007 using binoculars (7×50) and a GPS (e-trex Vista). It has been said that in practice no population survey is bias free and point sampling has certain advantages especially in dense forest (Bibby et al., 1992; Ralph et al., 1993) whereas line transects allow the observer to cover a wider range while simultaneously recording (Buckland et al., 2001). Here we adopted a transect method (Verner, 1985) instead of point count because we had to survey two different habitat types, forest as well as relatively open urban areas using one of the methods. We recorded all birds seen in a 50 m wide strip on each side of the transect, while walking. Transect lines were not straight and at
mid and high elevations there were a lot of topographical variations. However, transects did not cross habitat types. Within habitat types and study areas, transects were located randomly and transects were sufficiently separated (about 400 m) to avoid double counting of birds.

At each study area in each habitat three 1-km transects were used and each transect was visited monthly. The total number of transects was 18: 3 transects per habitat type × 2 habitat types (forest and urban) × 3 study areas. We visited each transect 12 times in the first year. The same transects were revisited 12 times in the following year. The time of sampling was between 07:30–10:30 h during winter and 05:00–08:00 h during summer. Sampling was avoided on rainy days. Identification of birds in the field was based on Grimmett et al. (1998).

Probability of detection was not used while comparing transect data between habitat types. As mentioned earlier, intensive and regular (monthly) census was made at each study area and habitat types continuously for two years to adjust the counts. Because of a large number of samples we argue that this method was adequate to record most of the bird species in a given location.

No parameters such as Bird Species Diversity (BSD) and Bird Species Richness (BSR) showed significant differences between years so we pooled the data across years (per habitat types and study areas) for the assessment of BSR and BSD. For the assessment of number of species, max-detection was taken into consideration. The mean value of individuals of each species recorded during walking three transects per month/habitat types/study area was used to calculate the number of individuals. The average of monthly mean abundance of both years was accounted for by calculating total abundance of the species. This value was then used to measure BSD and BSR. The mean value for individuals was also used to statistically compare abundance of species between habitats. In this comparison only those species were taken into consideration which were common between habitat types and study areas.

BSD and BSR were measured using Shannon’s index (H’) and Margalef’s index respectively (MacArthur and MacArthur, 1961, Magurran, 2004). To know the similarity among species composition at different elevations, Sorensen’s quantitative index (see Magurran, 2004) was used. Beta diversity (β = S/α0) where S is the total number of species recorded and α is the average sample diversity; scale 0 (minimum β diversity) to 1 (maximum β diversity) (Whittaker, 1960) value was obtained between habitats of each study area (low, mid and high elevation) to know extent of variation between habitat types.

Species can be categorized as rare depending on the criteria used to define rarity. Species that had less than five observations per sighting were categorized as rare. We used low relative abundance (RA <0.0001) criterion for defining rare species (see Gaston, 1994, Magurran, 2004).

For comparing species richness, species diversity, number of individuals and relative abundance of individuals between habitats and among study areas, a two way ANOVA was used (Zar, 1984). Two way ANOVA was also used to test for inter-seasonal differences in BSR and BSD values across study areas. Monthly values of BSR and BSD of both years from both habitat types were pooled and then compared by season (spring and summer: March to June; monsoon: July to October; winter: November to February).

We compared species richness between habitats and elevations using individual based rarefaction curves (Colwell et al., 2004). To estimate total species richness we used the non-parametric estimators of Chao 1, Chao 2, Jacknife 1 and Bootstrap (reviewed by Colwell and Goddington, 1994). We used EstimateS 7.5 (Colwell, 2006) to obtain the rarefaction curves and species richness estimators, after randomizing the sample 100 times.

2 Results

A total of 174 bird species (Appendix 1) belonging to 38 families were observed in urban and forest habitats. Seventy-nine species (45.4%) were found exclusively in forest, 14 species (8.0%) were restricted to urban habitat and 81 species (46.6%) were common to both habitat types. Two critically endangered bird species (IUCN 2006) of poor abundance, the white rumped vulture Gyps bengalensis (eight individuals) and cheer pheasant Craterous wallichii (five individuals), were also observed in forest habitat in Nainital.

In Nainital, the large billed crow Corvus macrorhynchos was found to be the most dominant species across both habitat types. Similarly, the Himalayan bulbul Pycnonotus leucogenys dominated both habitat types across Bhowali. While in Haldwani, different species such as the jungle babbler Turdoides striatus and red vented bulbul Pycnonotus cafer dominated the forest and urban habitat respectively. Irrespective of altitudinal variation, the house sparrow Passer domesticus was the second most dominant species in urban habitats. Some song birds such as blue whistling thrush Myiophonus...
caeruleus and streak laughing thrush Garrulax lineatus were dominant in both habitats at high and mid elevations but absent from low elevations. Black drongos (Dicrurus macrorhynchos) were found in both habitats at low and mid elevations but did not occur at high elevation (Table 1).

Analysis revealed that forest habitat had higher bird diversity and species richness than urban habitats: BSR (Two way Anova: 14.35 vs 8.69; $F_{1,35} = 5.57, P < 0.01$), high BSD (4.00 vs 3.54; $F_{1,35} = 3.96, P < 0.01$), high abundance (19371 vs 18361; $F_{1,35} = 6.30, P < 0.01$) and more rare species (17 vs 5). A significantly higher BSR (Two way Anova: $F_{2,35} = 25.87, P < 0.01$), BSD ($F_{2,35} = 14.25, P < 0.01$) and abundance ($F_{2,35} = 4.18, P < 0.01$) were observed at mid elevations (Bhowali) than low (Haldwani) and high elevations (Nainital).

Species rarefaction curves (Fig. 2) from different habitats and elevations also showed that forest habitat had a higher number of avian species than urban habitats, and that the mid elevation site (Bhowali) had a higher BSR than sites at low or high elevations. These observations are further supported by the majority of estimators of species richness (Table 2).

The similarity index showed greater overlap/similarity (49%) between bird communities at high (Nainital) and mid elevations (Bhowali) than between high and low elevations (31% Haldwani) or between mid and low elevations (43%). A comparison of bird communities between forest and urban habitats revealed low values of beta diversity in each study area (high elevation 0.18, mid elevations 0.24 and low elevation 0.23) indicating greater similarity in species composition between habitat types. However, when bird communities were compared among study areas relatively high beta diversity values (0.64 for urban and 0.58 for forest) were observed between high and low elevations (showing greater species variation between these two study areas) than between mid and low elevations (0.49 for urban and 0.48 for forest) or between high and mid elevations (0.41 for urban and 0.38 for forest).

Of 174 species, 26 shared both habitats across all study areas. Of these, the abundance of five species was found to be significantly higher at high altitudes, 12 at mid altitudes, and five at low altitudes. The three remaining species did not differ in abundance across habitat types or study sites. However, 12 species were found at lower abundance in urban areas than forest and the abundance of 11 species was high in urban habitats (Table 3).

Our study reveals that urbanization decreases BSR and BSD but can increase the abundance of some species. For example, 11 species including the large billed crow Corvus macrorhynchos, red vented bulbul Pycnonotus cafer, common myna Acridotheres tristis, blue rock pigeon Columba livia, Himalayan bulbul Pycnonotus leucogenys, white wagtail Motacilla alba, common crow Corvus splendens, ring dove Streptopelia decaocto, spotted munia Lonchura punctulata, spotted dove Streptopelia chinensis and pied myna Sturnus contra, were found at higher numbers in urban habitats (Table 3).

We found that BSD and BSR fluctuated across seasons for all study sites (BSD range: 4.15 ± 0.26 at high altitude in winter to 4.88 ± 0.14 at mid altitude in spring/summer; BSR range: 5.64 ± 0.77, at high altitude in monsoon to 8.32 ± 0.82 at mid altitude in spring/summer). BSD and BSR were high in spring/summer at mid (Bhowali) elevations (Two-way Anova: BSD: $F_{2,22} = 5.71, P < 0.05$; BSR: $F_{2,22} = 5.17, P < 0.008$). The interaction value between seasons and study areas was also found to be significant (BSD: $F_{3,22} = 11.54, P < 0.01$; BSR: $F_{4,22} = 8.71, P < 0.01$). During the study period, eight species, Pycnonotus leucogenys, Myiophonus caeruleus, Culicicapa ceylonensis, Pericocetus ethologus, Saxicola caprata, Motacilla cinerea, Motacilla alba, Hirundo rustica were altitudinal migrants within the study area and two species, Terpsiphone paradisea and Eumyias thalassina, were recorded as summer visitors that visited the study area mostly from the Deccan plateau (southern India).

3 Discussion

ANOVA test carried out between bird communities of forest and urban habitats revealed that forest had higher bird diversity, species richness and abundance than urban habitats, which is understandable because urbanized areas lack suitable vegetative patches, shrubs and canopy cover that limits food density and diversity, nest placement, predator avoidance, and escape. However, the highest richness is not always on the most natural habitats but may occur in moderately perturbed ones (Nourteva, 1971; Lancaster and Rees, 1979; Jokimaki and Suhonen, 1993). Though urbanization decreased BSR and BSD in this study, interestingly some species increased and dominated urban avian communities. Similar findings have been reported from some European areas (Huhtalo and Jarvinen, 1977; Jokimaki et al., 1996; Clergeau et al., 1998). Even the removal of trees in a deciduous forest can result in an increase in individuals and dominance of common species, in addition
Comparative studies on avifauna structure in urban and forest habitats have not been done on the Indian subcontinent and comparison with other tropical areas may not be possible. However, there are some reports from the neotropics and Australian tropics indicating that urbanization might indirectly decrease BSR, as in European areas, through decreasing primary productivity and that human-altered habitats have potential ecological values for birds (Jones, 1981; Green et al., 1986; Ruszczyk et al., 1987; Kentish et al., 1995; Petit et al., 1999; Daily et al., 2001). Results based on beta diversity analysis indicate that the forest habitat contributes significantly to the overall bird community of the study area while the urban habitat depends to a large extent on the forest (surrounding) habitat for its bird assemblages. Thus, it can be said that besides local, landscape level resources (such as surrounding forest) may be important in determining the distribution of birds in urban area.

We also found that at a community level BSR and BSD peaked at moderate levels of urbanization at Bhowali town (mid elevation). This could be due to the availability of different Ficus species (viz. Ficus palmae, F. auriculata, F. loer, F. semicordata etc.) at mid elevation site, that provide differential sources of food for omnivores and frugivores. In addition, these trees support rich insect diversity, increasing the chances of survival of insectivores. Similarly, Rahbek (1995, 1997) and Blair (2004) reported that species richness and diversity peaked at moderate levels of urbanization due to abundance and diversity of resources available to birds. Thus, diversity in the availability of resources in a particular habitat may be an important factor that determines the structure and diversity of bird communities.
Passer domesticus and Columba livia were found to reside year round throughout our study sites. Also, P. domesticus was a dominant species in our urban habitat surveys. In other studies also, urban habitats have been shown to be dominated by a few sedentary bird species with wide geographical ranges (e.g., P. domesticus or C. livia) (Blair, 1996; Jokimaki et al., 2002). In this study, the presence of P. domesticus as a dominant species is a promising sign as there are reports of a sharp decline in this species in many urban habitats around the world (Peach et al., 2006; De Laet and Summers-Smith, 2007). It could be argued that the availability of easier and more nesting sites in the form of old traditional housing in the study area accounts for the high abundance of house sparrows.

BSR varied considerably (91 to 113 species) with elevation. BSR was highest (113 species) at Bhowali (mid elevation; 1450 – 1700 m asl) and lowest (91 species) at Nainital (high elevation; 1900 – 2450 m asl). This difference in BSR among study areas could be due to elevation, and vegetation differences associated with elevation and not caused by the presence of a group of mid altitude specialists. For example, the Bhowali forest is mixed (e.g., Pinus roxburghii, Quercus leucotrichophora along with some Ficus species found in urban habitat as well) providing better food resources for bird communities compared to Nainital or Haldwani forests where mostly Cedrus deodara and Shorea robusta trees predominate, respectively. Probably due to this habitat characteristic the Bhowali forest (mid elevation) supports more avian species (113) compared to low (103) and high (91) elevation forests. Similarly, the positive relationship between habitat characteristics and BSR has been demonstrated by a number of studies (Wines, 1989; Wilson and Comet, 1996; Raman et al., 2005; Metlock and Edwards, 2006; Vijayan and Gokula, 2006). It has been suggested that species similarity or turnover along elevation is the consequence of vegetation types and climatic conditions (Terborgh, 1977; Terborgh and Weske, 1975; Rahbek, 1995, 1997; McCain 2007a, b). Elevational range size varies among species and depends on various factors such as habitat availability, dispersal and establishment abilities, competition, predation, local abundance, and climate (Gaston, 1996; McCain, 2006). Variation in BSR can be explained in part by the area of different elevational bands e.g. foothills and lower elevational zones and mountain ranges usually have larger land area than upper elevations, which tend to be steeper (Rahbek, 1997; Kattan and Franco, 2004). However, further investigations are required to understand whether these patterns of altitudinal distribution conform to either the structural or botanical classification of vegetation variation with altitude.

We found that the high and low elevations contained more rare species (17 and 16 respectively) than mid (12) elevations. A higher number of rare species in any habitat may indicate the availability of minimum resources for those species. However, the occurrence of rare species, in addition to their unique contribution to the biological diversity of an area, may also indicate unique habitat or an area of conservation interest (Master, 1991). It seems obvious, therefore, that the study area needs the attention of conservation biologists.

Results indicated that the BSD and BSR fluctuated across seasons at all elevations. These fluctuations in BSR and BSD may largely be due to seasonal movements of migratory birds from one altitude to the other of the study area. The impact of environmental factors might also cause the seasonal movements of birds within and between habitats (Perrins and Birkhead, 1983; Loiselle and Blake, 1991; Norris and Marra, 2007). However, we did not observe any difference in BSR and BSD between habitat types. Variation in temperature and intensity of rain is greater in temperate regions and at higher elevations (Karr, 1976; Terborgh, 1977; Vazquez and Givnish, 1998) and causes high seasonal fluctuations in birds. Apart from weather, the seasonal changes in BSD and BSR could also be caused by fluctuations in resource availability (Loiselle and Blake, 1991; Kai and Corlett, 2002; Hulbert and Haskell, 2003; Norris and Marra, 2007). Whatever the cause may be, in this study the seasonality of bird occurrence strongly influenced species diversity and richness patterns along elevational gradients.

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### Appendix 1  Avian species recorded in forest and urban habitats

| Family            | Common Name               | Scientific Name               | Habitat |
|-------------------|---------------------------|-------------------------------|---------|
| Muscicapidae      | Aberrant bush warbler     | Cettia flavolivacea           | Forest  |
|                   | Ashy prinia               | Prinia socialis               | Forest  |
|                   | Asian paradise flycatcher | Terpsiphone paradisi          | Forest  |
|                   | Blue throated flycatcher  | Cyornis unicolor              | Forest  |
|                   | Buff-barred warbler       | Phylloscopus pulcher          | Forest  |
|                   | Faintail warbler          | Cisticola exilis              | Forest  |
|                   | Greenish warbler          | Phylloscopus trochiloides     | Forest  |
|                   | Grey-head canary flycatcher | Calbicapa ceylonensis       | Forest  |
|                   | Grey-winged black bird    | Turdus boulboul               | Forest  |
|                   | Lemon-rumped warbler      | Phylloscopus chloronotus      | Forest  |
|                   | Lesser whitethroat warbler| Sylvia currucia               | Forest  |
|                   | Pale-footed bush warbler  | Cettia pallidipes             | Forest  |
|                   | Red-throated flycatcher    | Ficedula parva                | Forest  |
|                   | Rufous-bellied niltava    | Niltava sundara               | Forest  |
|                   | Rufous sibia              | Heterophasia capistrata       | Forest  |
|                   | Rusty-cheeked sumiter babbler | Pomatorhinus erythrogenys   | Forest  |
|                   | Small niltava             | Niltava macgrigoriae          | Forest  |
|                   | Striated babbler          | Turdoides earlei              | Forest  |
|                   | Thick-billed flower pecker| Dicaeum agile                 | Forest  |
|                   | Ticklle's leaf warbler    | Phylloscopus affinis          | Forest  |
|                   | Whiskered yuhnia          | Yuhina flavicollis            | Forest  |
|                   | White-crested laughing thrush | Garrulax leucolophus    | Forest  |
|                   | White-tailed rubythroat   | Luscina pectoralis            | Forest  |
|                   | Yellow-bellied fantail    | Rhipidura hypoxantha          | Forest  |
|                   | Yellowish-bellied bush warbler | Cettia acanthizoides      | Forest  |
| Picidae           | Black-rumped flameback    | Dinopium benghalense          | Forest  |
|                   | Brown-fronted woodpecker  | Dendrocopos auriceps         | Forest  |
|                   | Brown-capped pygmy woodpecker | Dendrocopos nasus         | Forest  |
|                   | Common flameback          | Dinopium javanense            | Forest  |
|                   | Fulvous-breasted woodpecker | Dendrocopos macei            | Forest  |
|                   | Great slaty woodpecker    | Mulleripicus pulverulentus    | Forest  |
|                   | Greater flameback         | Chrysocolaptes lucidus        | Forest  |
|                   | Grey capped pygmy woodpecker | Dendrocopos canicapillus     | Forest  |
|                   | Grey headed woodpecker     | Picus canus                   | Forest  |
|                   | Himalayan flameback       | Dinopium shorii               | Forest  |
|                   | Himalayan woodpecker       | Dendrocopos himalayensis      | Forest  |
|                   | Lesser yellownape woodpecker | Picus chlorolophus            | Forest  |
|                   | Slaty-bellied woodpecker   | Picus squamatus               | Forest  |
|                   | Streak-throated woodpecker | Picus xanthopygaeus           | Forest  |
| Phasianidae       | Cheer pheasant            | Cotrelus wallachii            | Forest  |
|                   | Common quail              | Coturnix coturnix             | Forest  |
|                   | Indian peafowl            | Pavo cristatus                | Forest  |
|                   | Kalij pheasant            | Lophura leucomeleos           | Forest  |
|                   | Koklas pheasant           | Pucrasia macrolopha           | Forest  |
|                   | Red jungle fowl           | Gallus gallic                 | Forest  |
| Campephagidae     | Long tail minivet         | Pericrocotus ethologus        | Forest  |
| Order          | Family               | Species                  | Habitat   |
|----------------|----------------------|--------------------------|-----------|
| Accipitridae   | Large cuckoo shrike  | Coracina macei           | Forest    |
|                | Small tail minivet   | Pericrocotus cinnamomeus | Forest    |
|                | Besra sparrow hawk   | Accipiter virgatus       | Forest    |
|                | Black shoulder kite  | Neophron percnopterus    | Forest    |
|                | Booted hawk eagle    | Hieraaetus pennatus      | Forest    |
|                | Common buzzard       | Bateo bateo              | Forest    |
| Alaudidae      | Eurasian skylark     | Alauda arvensis          | Forest    |
|                | Oriental skylark     | Alauda gulgula           | Forest    |
| Corvidae       | Black head jay       | Garrulus lanceolatus     | Forest    |
|                | Eurasian jay         | Garrulus glandarius      | Forest    |
| Cuculidae      | Greater coucal       | Centropus sinensis       | Forest    |
|                | Lesser coucal        | Centropus bengalensis    | Forest    |
| Motacillidae   | Paddy field pipit    | Anthus rufulus           | Forest    |
|                | Tree pipit           | Anthus trivialis         | Forest    |
| Oriolidae      | Black hooded oriole  | Oriolus xanthornus       | Forest    |
|                | Common iora          | Aegithina tiphia         | Forest    |
| Paridae        | Green backed tit     | Parus monticolus         | Forest    |
|                | Grey crested tit     | Parus dichrous           | Forest    |
| Passeridae     | Chestnut shouldered petronia | Petronia xanthocollis | Forest |
|                | Russet sparrow       | Passer rutilans          | Forest    |
| Strigidae      | Brown wood owl       | Strix leptogrammica      | Forest    |
|                | Spotted owlet        | Athene brama             | Forest    |
| Campephagidae  | Common wood shrike   | Tephrodornis pondicerianus | Forest |
| Capitonidae    | Brown-headed barbet  | Megalaima zeylanica      | Forest    |
| Certhiidae     | Eurasian tree creeper| Certhia familiaris       | Forest    |
| Columbidae     | Emerald dove         | Chalcophaps indica       | Forest    |
| Dicaeidae      | Fire-breasted flower pecker | Dicaeum ignipectus   | Forest    |
| Dicruridae     | Spangled drongo      | Dicurus houtentiottus    | Forest    |
| Fringillidae   | Common rose finch    | Carpodacus erythrinus    | Forest    |
| Nectariniidae  | Crimson sunbird      | Aethopyga siparaja       | Forest    |
| Psittacidae    | Alexandrine parakeet | Psittacula eupatria      | Forest    |
| Pycnonotidae   | Himalayan bulbul     | Pycnonotus leucogenys    | Forest    |
| Sturnidae      | Chestnut-tailed starling | Sturnus malabaricus   | Forest    |
| Hirundinidae   | Common swallow       | Hirundo rustica          | Urban     |
|                | Wire-tail swallow    | Hirundo smithii          | Urban     |
| Muscicapidae   | Common babbler       | Turdoides caudatus       | Urban     |
|                | White-throated thrush| Garrulax leucolophus     | Urban     |
| Cuculidae      | Pied-crested cuckoo  | Clamator jacobinus       | Urban     |
| Ardeidae       | Intermediate egret   | Mesophoyx intermedia    | Urban     |
| Capitonidae    | Large green barbet   | Megalaima lineata        | Urban     |
| Corvidae       | Eurasian jay         | Garrulus glandarius      | Urban     |
| Oriolidae      | Eurasian golden oriole | Oriolus oriolus         | Urban     |
| Passeridae     | House sparrow        | Passer domesticus        | Urban     |
| Sturnidae      | Common myna          | Acridotheres tristis     | Urban     |
| Zosteropidae   | Oriental white eye   | Zosterops palpebrassus   | Urban     |
| Hemiprocnidae  | House swift          | Apus affinis             | Urban     |