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**AVIAN COMMUNITIES IN THE
RIPARIAN AREAS
OF
BORI WILDLIFE SANCTUARY, INDIA.**

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SUBMITTED BY

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SUMMARY

Riparian areas are important as special habitats and corridors for wildlife. However, in India, riparian areas have not been studied to any detail. Also, not much is known about the avifauna of riparian habitats. The vegetation near a riparian area tends to be dense and hence distinct owing to constant availability of water. Riparian areas come under heavy use, both by livestock as well as wild animals because of the presence of water and forage. The avifauna of riparian areas is rich due to its floral complexity and structure and resources like fish and insects.

This study quantified bird species diversity, avian guilds and avian community structure found in four riparian areas (a flood plain, a riparian scrub, a disturbed nulla and an undisturbed nulla) of Bori sanctuary in Central India. The riparian areas were compared with the adjoining deciduous forest for avifaunal differences. Vegetation was studied along the riparian areas and the deciduous forests, using circular plots. Tree and shrub densities, vertical stratification of foliage and species richness were quantified. Line transects were used to estimate bird species richness and abundance.

Bird species richness was correlated to negative variables for the two seasons. In summer the BSR was highly correlated with CC and in winters with CC. Stepwise multiple regression was used to create a habitat model for BSR in summer and in winter.

Community patterns show seasonal change and also respond to structural changes of habitat. The role of floristics also cannot be denied.

CHAPTER 1 : INTRODUCTION

1.1.RIPARIAN AREAS

Riparian areas are well defined landscape features; ecotonal and elongate with a very high edge to area ratio. They have large energy, nutrient and biotic interactions with aquatic systems on the inner margin and upland terrestrial ecosystems on the outer margin (Odum 1978). Though they cover very little area, they are very productive in terms of biomass. They contribute to the *alpha* and *beta* diversity of an ecosystem (Thomas *et al.* 1979). Riparian ecosystems show a lateral movement of water and the key factor determining vegetation composition and productivity is the hydroperiod (Ewel 1977). Due to the availability of moisture, riparian areas have denser vegetation than the surrounding areas.

Ecological values of riparian areas have seldom been studied and have been demonstrated only by a few ecologists in the recent past (Rice *et al.* 1981; Rodgers 1990; Finch 1989). Riparian areas serve as migratory corridors and also provide food and cover to animals. The linear nature of the riparian habitat magnifies the edge effect (Thomas *et al.* 1979; Omhart & Anderson 1986). Their attributes as sources of cover and food are further heightened in the dry seasons in deciduous areas (Rodgers 1990).

Riparian areas are subjected to a lot of anthropogenic pressures such as settlements, lopping, logging, grazing, bunding, recreational and developmental activities (Thomas *et al.* 1979; Johnsingh & Joshua 1989). Most of the literature available on riparian areas deals with the New world. Not much work has

been done on the riparian areas of the Indian subcontinent.

1.2. AVIFAUNA OF RIPARIAN AREAS:

Bird species concentrations in the riparian areas are often very high. Hubbard (1977) reported that two river valleys in New Mexico, supported 16-17% of the entire avifauna of the area. Rice *et al.* (1983) had found a sizeable annual and seasonal turnover of bird species in the Colorado river valley. Knopf (1985) found that the riparian areas of the Platte river valley in Colorado Front Range contained 82% of the entire avifauna of that area. Katti (1989) and Rai (1991) found a greater bird species diversity (BSD) in the riverine areas than in the surrounding habitat types. This phenomenon of high BSD is most pronounced in the Xeroriparian (arid) areas (Johnson & Haight 1985).

Stevens *et al* (1977) found that censuses in riparian habitats commonly resulted in a large numbers of migrant birds when compared to the adjacent upland habitats; since riparian areas served as in transit stopover sites during avian migrations. Riparian bird communities also tend to be stable between years (Knopf 1985).

Riparian areas offer several resources such as fruits (Rodgers 1990), fish and insects (Meehan *et al* 1977). These food resources attract frugivores, piscivores and insectivores. Some birds like the grey wagtail (*Motacilla cinerea*), brown fish owl (*Bubo zeylonensis*) and sand martin (*Riparia paludicola*) are exclusive to riparian areas. Finch (1989) had shown that habitat

heterogeneity in the lower elevations of riparian areas supported greater BSD and BSR as they have a wider resource base as compared to riparian areas at higher elevations.

There is a need to investigate riparian areas in greater detail as developmental activities and invasions by exotic vegetation have led to serious changes in riparian community dynamics (see Cohan *et al.* 1978; Johnsingh & Joshua 1989; Brown & Johnson 1985; Hunter *et al* 1985; Rodgers 1990; Ohmart *et al* 1985, Rice *et al*).

1.3.AVIAN COMMUNITY ECOLOGY

Avian community ecology gained momentum with the "MacArthur approach" in the 1960's. MacArthur (1964, 1971a, 1971b) laid stress on the patterns in nature - what kind of general events occur and what determines them. Existent patterns in communities are often determined by species composition and such attributes as their numbers, distribution, abundance, morphology and behaviour in relation to the environment (Weins 1989).

Birds have been popularly used for investigating hypotheses into community ecology as they are more conspicuous, vocalize frequently and are diurnal. Also a lot has been documented on their behaviour, natural history, systematics and distribution (Manan & Meslow 1980, Wiens 1989). They can be used effectively as indicators of habitat quality (Manan & Meslow 1980)

The special features that would determine the guilds

and species in a habitat are feeding sites, perching sites, nest sites, predation etc. (Cody 1985). The most commonly quantified aspects of an avian community are species richness, species diversity and guild richness which are then related to structural variables of the habitat such as floristics, foliage density, foliage diversity, canopy cover, vertical height diversity etc. (James & Shugart 1970, Schroeder 1987).

1.4.THE STRUCTURAL VARIABLES:

After MacArthur & MacArthurs' (1961) pioneering work in a temperate deciduous forest, positively relating bird species diversity (BSD) to foliage height diversity (FHD), there has been a subsequent plethora of ecological literature debating the same. Karr & Roth (1971), Recher (1969), James (1971) corroborated the hypothesis with their studies while some (Johnsingh & Joshua in press, Terboggh 1985, Wiens & Rotenberry 1981, Rai 1991) have shown dissent.

Willson (1974) had found a strong correlation between percentage canopy cover (CC) and BSD in a deciduous while Daniels (1989) had shown a negative correlation between the same variables in an evergreen forest.

Roth (1976) had found that horizontal vegetative patchiness and BSD were related positively. Pearson (1974, 1975) had shown that birds prefer certain strata of the vegetation.

The role of floristics (plant species) has been underplayed in avian ecology (Rice *et al* 1984). The availability of food species is of prime importance to frugivores which share

a mutualistic relationship with fruit bearing trees (Herrera 1985).

1.5.GUILDS:

Root (1967) had defined a guild as "a group of species that exploit the same class of environmental resources in a similar way". Guilds are fewer as compared to the number of species and easier to handle while analysing communities. Also they allow a more comprehensive view of the community. They are arbitrary groupings of species and could be based on feeding strategies, breeding strategies or other factors such as species size, habitat preference and behaviour. Species in a guild will show similar reactions to any impact to the resources (Severinghaus 1981). The width of a guild (i.e. the number of species it encompasses) and the species classified therein depend on the objectives of the investigator.

1.6.OBJECTIVES OF THE STUDY:

1. To study study patterns in riparian bird communities.
2. To develop a predictive model for Bird species richness.
3. To examine relationships between bird communities and structural variables of vegetation.
4. To examine seasonal changes take that place in community dynamics.
5. To estimate the impact of human disturbance in the

form of grazing, construction, nursery activity and human dwellings on bird communities by comparing a disturbed and an undisturbed nulla.

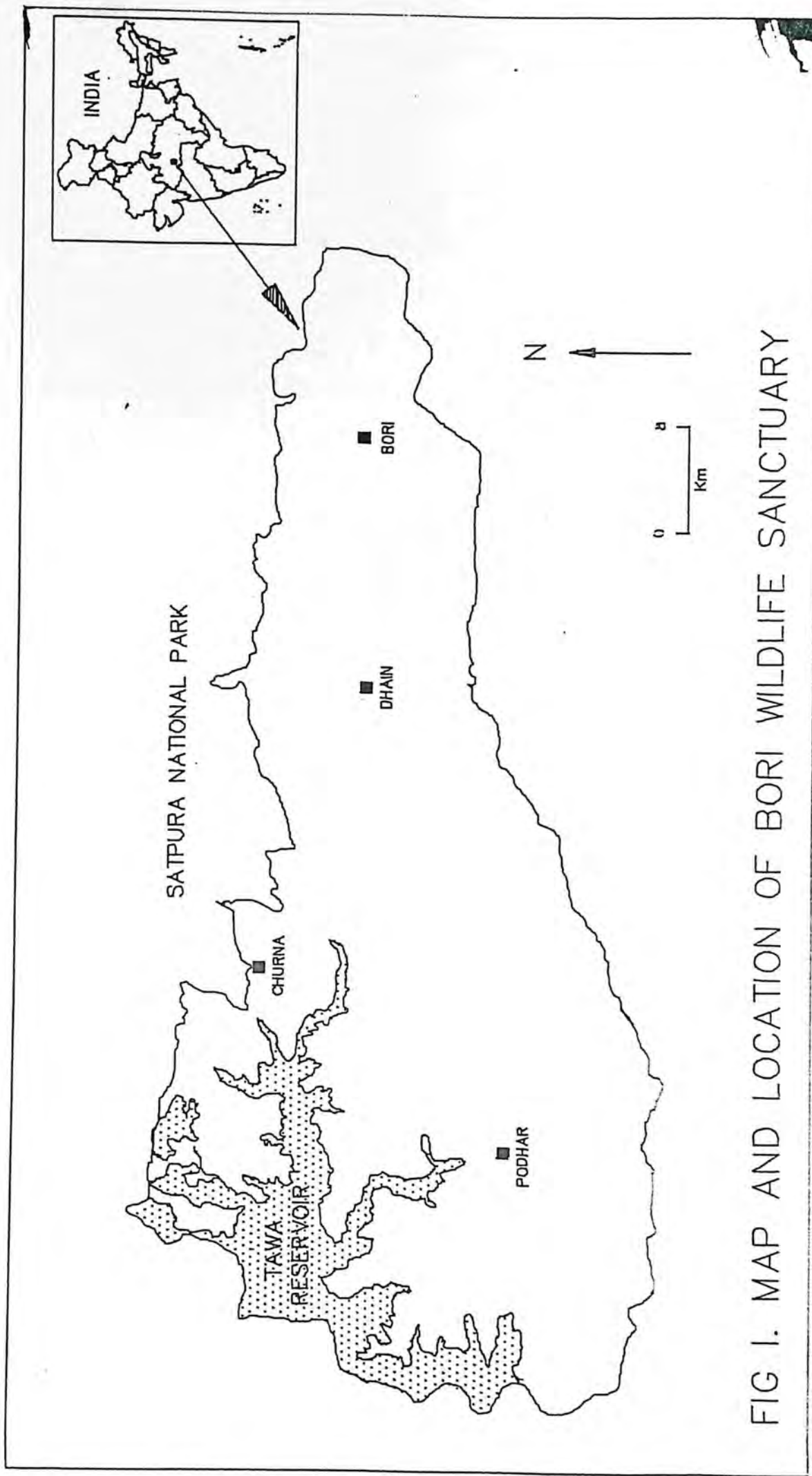


FIG 1. MAP AND LOCATION OF BORI WILDLIFE SANCTUARY

CHAPTER 2 : STUDY AREA

2.1 LOCATION

Bori wildlife sanctuary (WLS) is located in Hoshangabad district, Madhya Pradesh, India at $22^{\circ} 19'$ to $22^{\circ} 30'N$ and $77^{\circ} 56'$ to $78^{\circ} 20'E$ (Fig.1). It lies on the southern slopes of the Satpura mountains and covers an area of 486 sq. km. Altitude varies from 305 m to 1045 m above MSL. It has the distinction of being the first forest reserve declared in India, in 1865. It was notified as a sanctuary in 1931 by the British and later brought under the Wildlife Protection Act in 1972 and 1977 (Gangopadhyay 1985).

Bori Wildlife Sanctuary is bounded in the north by the Mahadeo ranges which form a part of the Satpura National Park and Pachmarhi Sanctuary and on the western and the southwestern sides by the river Tawa reservoir. It is well traversed by streams and rivulets of the Bori and the Sonbhadra rivers which ultimately drain into the Narmada.

Bori WLS is at present also being studied by the Wildlife Institute of India, Dehradun for its biodiversity.

2.2. TOPOGRAPHY AND GEOLOGY

The terrain of the Sanctuary varies from steep slopes in the East to flat and undulating terrain in the West. The rocks belong to the Upper and Lower Gondwana series and consist primarily of coarse sandstone and limestone (Gangopadhyay 1985).

2.3. CLIMATE

Winter (November - February), Summer (March - June) and monsoon (July - October) are the three distinct seasons in the sanctuary. There are occasional showers and gusts of wind in the premonsoon season. Mean annual rain fall is 2067.80 mm (Gangopadhyay 1985). Maximum and minimum temperatures during the study period were - min. 6 ° C in winter to 47 ° C max. in summer.

2.4. FOREST TYPES

According to Champion and Seth (1968), the major forest type of Bori is South Indian Moist Deciduous Forest, sub type Moist Teak Forest (3B/C1b). Rodgers and Panwar (1989) in their biogeographic classification have categorised this as Teak forest and Teak-Sal transition zone.

The subtypes seen are dry deciduous and moist teak forests. Bori Wildlife Sanctuary has been intensively heavily worked for teak and bamboo and hence a major part of the Sanctuary has been under commercial forestry operations till 1991. Due to the presence of several streams and nullas, Bori also has fairly long stretches of riparian forests.

The forest has an average stand height of 25 metres. *Tectona grandis* is the major emerging species in the forest canopy. The canopy also consists of species such as *Ougenia oojeinensis*, *Terminalia tomentosa*, *Anogeissus latifolia*, *Adina cordifolia* and *Mitragyna parviflora*. *Dendrocalamus strictus* forms a prominent middlestorey with *Lagerstroemia parviflora*,

Aegle marmelos, *Diospyros melanoxylon*, *Chloroxylon swietinia* and *Zizyphus xylopyra*. The shrub layer consists chiefly of *Lantana camara*, *Colebrookia oppositifolia* and *Helicteres isora*. The common climbers are *Ventilago spp.*, *Bauhinia vahlii* and *Butea superba*. The common epiphytic and parasitic plants on trees are *Vanda tessellata* and *Dendrophoe falcata* respectively.

2.5. THE INTENSIVE STUDY AREAS.

The intensive study areas selected were four different types of riparian areas and one deciduous forest. The vegetation of riparian areas is unique and characteristic. It requires well drained soil and the root systems often have to be in touch with water (Mason et al 1984). The riparian areas are classified as Riparian fringing forests (37.4E/RS1) by Champion & Seth (1968). The major tree species found in the riparian areas are *Terminalia arjuna*, *Syzigium cumini* and *Mangifera indica*.

The riparian areas were:-

1. A Floodplain: this lay on the banks of the Sonbhadra river approximately 2km. from Dhain village (fig.2). Due to frequent flooding during the monsoons, not much ground vegetation is present. The canopy chiefly consists of trees such as *Terminalia arjuna* and *Syzigium cumini* occasionally broken by *Lannea coromandalica* and *T. tomentosa* at the riparian area and deciduous forest edge. The middle canopy consisted of bamboo (*Dendrocalamus strictus*) and trees such as *D. melanoxylon* and a few *Mallotus*

phillipensis. There were also several regeneration stands of *T.arjuna* and *S.cumini*. The ground layer consisted of *Cirsium* and *Argemone mexicana*. Grass cover is extremely sparse. The sandy river bed has a few scattered stands of *Tamarisk* sps.

2. Scrub area: This riparian habitat also on the banks of the Sonbhadra. The effect flooding is most apparent in this area. The soil is loose and there is a lot of rubble. Tree growth is very sparse, scattered and extremely stunted. There is not much of a middle canopy and hardly any upper canopy either. The shrub layer consists of *Vitex negundo*, *Woodfordia fruticosa* and *Syzigium cumini*. There are a few scattered *T.arjuna* and *B.monosperma*.

3. Nulla: this refers to the streams and brooks.

Two nullahs were chosen:-

i) Undisturbed nulla: The Jhunkar nulla was chosen. It is about 5km. from Churna. It experiences comparatively little anthropogenic pressures. The vegetation was mainly *T.arjuna* and *S.cumini* in the top layer occasionally broken by *Adina cordifolia*, *Tamarindus indica*, *T.tomentosa*, *Madhuca indica* and *T.grandis*. The middle layer had *Mallotus*, *D.strictus* and *D.melanoxydon*. Shrub layer had a few scattered clumps of *Lantana* and saplings of *T.arjuna* and *S.cumini*. The ground layer had *P.acaulis*.

ii) Disturbed nulla : This is the Bhainsa nulla adjacent to the Churna village. A dense tree canopy is formed by *T.arjuna* and *S.cumini* occasionally interrupted by *Bombax ceiba*, *Mangifera indica* and *Pterocarpus marsupium*. The middle layer had *Aegle marmelos*, *D.strictus* and regeneration stands of *T.arjuna*. Anthropogenic influence is acutely evident in the plantations of exotics (eg. *Eucalyptus*, *Dalbergia latifolia*), bunding, destruction of streamside vegetation by domestic elephants, buildings, lopping, cutting and grazing. Ground cover is mainly that of *Lantana* and *P.acaulis*.

4. The deciduous area: The major tree species is *T.grandis* in the upper canopy along with *T.tomentosa* and *M.indica*. The middle layer had *Z.xylocarpa*, *A.marmelos*, *D.melanoxylon*, *T.grandis*, *B.monosperma*, *H.antidysentrica* and *P. embelica*. The shrub layer was mainly *Lantana*, *D.melanoxylon* and *B.monosperma* saplings. A few *W.fruiticosa* plants could also be seen.

2.6.MAMMALIAN FAUNA

Twenty five species of mammals were recorded during the study. The major carnivores are tiger (*Panthera tigris*), leopard (*Panthera pardus*), dhole (*Cuon alpinus dhukunensis*) and sloth bear (*Melursus ursinus*). The major ungulates seen are gaur (*Bos gaurus*), sambar (*Cervus unicolor*), chital (*Axis axis*), nilgai (*Boselaphus tragocamelus*), muntjac (*Muntiacus muntjac*), chowsingha (*Tetraceros quadricornis*) and chinkara (*Gazella*

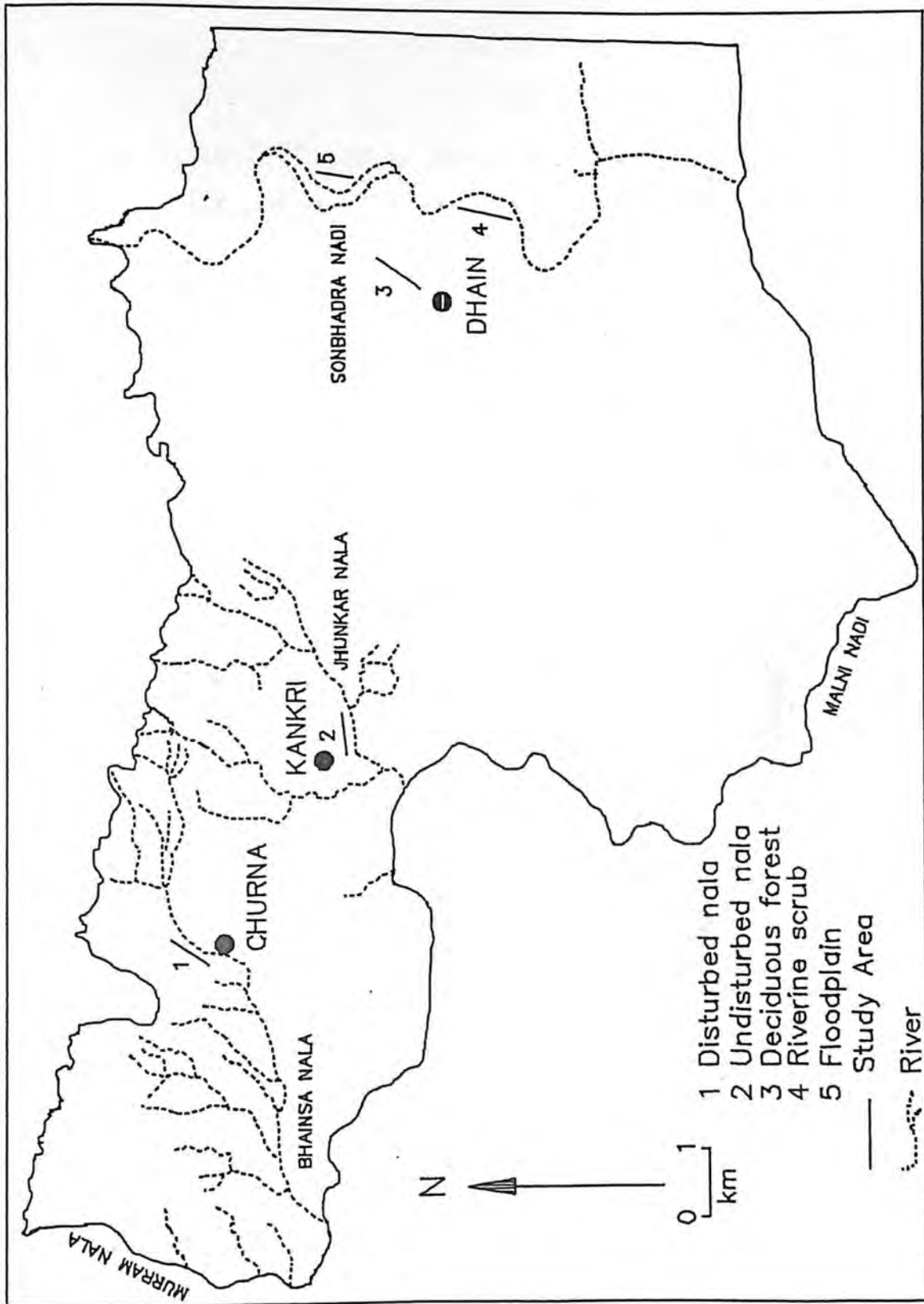


Fig.2 Intensive study area with transects

gazella).

2.7. HERPETOFAUNA

Checklist of herpetofauna of the area is not available. mugger (*Crocodylus palustris*), rat snake (*Ptyas mucosus*) and buff striped keelback (*Amphisema stolata*) and monitor lizard (*Varanus bengalensis*) were recorded during the period of study.

2.8. AVIFAUNA

The Satpuras are an ornithological highway for migrant bird species to and from Peninsular India (Ali unpubl.). Bori lies at the confluence of the Northern and Southern avifaunal elements of the Indian subcontinent. Two hundred and fifteen species of birds were recorded in the Sanctuary during the course of the study. The Sanctuary has both grey and red jungle fowl which are even reported to hybridize (Ali and Ripley 1986).

2.9. PEOPLE AND ANTHROPOGENIC PRESSURES

There are seventeen forest villages inside the Sanctuary, of which ten are located in the south. The principal communities of people are the Gonds, the Korkhus, Thatiyas and the Gowlis. The Gonds and Korkhus are aboriginal tribes. The total human population in the villages is 3572 people (Gangopadhyay, 1985). At present there is a plan to resettle some of the villages near the Tawa river (M.P.Chacko, Sanctuary

Superintendent pers.comm.).

The Anthropogenic pressures noticed were cattle grazing, lopping of trees, collection of fuelwood, collection of non wood forest produce and burning of leaf litter during summers to facilitate the search for shed antlers of chital and sambar.

CHAPTER 3 : METHODS

3.1. AVIAN COMMUNITY

The study concentrated on four different riparian habitats and one deciduous area. Field work extended from mid November 1992 to the first week of May 1993. The initial five weeks were spent in making a basic checklist of birds to which additions were made as and when spotted. The time period was also spent in surveying the area, laying transects and familiarising myself with birdcalls and vegetation.

Bird communities were sampled using line transects (Emlen, 1971). One permanent transect was laid in each of the riparian areas studied. Depending on the continuity of vegetation type, the length of the transect was either 650m or 1km. The line transect method was selected because of its relative efficiency and simplicity (Verner 1985).

Each line transect was walked in the daytime when bird activity was thought to be at its highest (Robbins 1981). The transects were walked at a constant pace. Birds encountered within a semicircle in front of me were recorded along with the parameters listed below. Birds behind me were ignored to eliminate double counting. The parameters recorded on the data sheet were :-

1. Maximum and minimum temperatures of the day.
2. Bird species seen and number of birds.
4. Perpendicular distance of the sighting from the line of transect. If the perpendicular distance could not be estimated the the sighting angle and the angular distance were recorded. Birds in flocks were grouped as single detections and the distance to the centre of the flock was

estimated.

5. Height of the bird from the ground.

6. Position of the bird in the tree canopy ie. proximal to the tree axis, distal to the tree axis, in the middle. Also if it was within the canopy, above it or below.

Distances were estimated visually. Calls were identified and classified into five distance categories; 0-5m, 5-10m, 10-25m, 25-35m and >35m.

Each transect was walked seven times in winter and six times in summer.

3.2. Vegetation

Guidelines given by James and Shugart (1970) were followed making modifications and additions when deemed necessary. To sample trees, plots of 10m radius were laid at every 50m. Within these plots tree species, GBH of individual trees, tree height and canopy height were recorded. Using the tree plot centre, within a radius of 5m., shrub species were recorded. Care was taken that all vegetation plots were at a distance of at least 15m from the edge of the water. Canopy cover was estimated using ocular tube method. At every vegetation plot, I walked in the two directions parallel to the transect and recorded presence/absence of foliage at twenty points.

To get a foliage profile, a bamboo pole was used at every 10m (Johnsingh and Joshua in press). The presence or the absence of foliage within a radius of .5m was recorded at the height intervals of .25m, .5m, 1.5m, 3m, 4m, 5m, 6m, 7m, 8m, 10m,

12m, 15m, 25m and 30m. The readings were pooled to get the percentage foliage at that level.

Foliage profiling and canopy cover estimation were done for both the seasons.

3.3. ANALYSIS

3.3.1. BIRD SPECIES DIVERSITY (BSD)

BSD was measured using Shanon's index- H' (Magurann 1988) as stated below

$$H' = - \sum_{i=1}^s p_i \log p_i$$

where p_i is the proportion of the i^{th} species in the sample. The drawbacks of using Shanon's index are that it can be deceptive in case there are any errors or discrepancies in sampling. It is also sensitive to the number of individuals of each species and the species -area effect (Magurran 1988, Rai 1991, James & Rathbun 1981).

3.3.2. BIRD SPECIES RICHNESS (BSR)

Rather than take absolute numbers of species, Rarefraction was used to standardize the data to fifty individuals. Rarefraction is a relatively unbiased method which utilizes Hurlbert's estimate

$$E_s = \text{summation} \left[1 - \frac{(N - N_i)}{N} \right]^{\frac{1}{n}}$$

Where E_s is the expected number of species,

N is the total no of individuals in the population

N_i is the number of individuals counted

n is the standardized sample size.

to estimate the number of species if a standard number of individuals were encountered in each habitat (James & Rathbun 1981, James & Wamer 1981, Magurran 1988). Rarefaction has been criticized because it results in a loss of information and can cause problems of misinterpretation at small sample sizes (Magurran 1988). BSR was calculated for both summer and winter. The package Stat Ecol (Ludwig & Reynolds 1988) was used.

3.3.3. FOLIAGE HEIGHT DIVERSITY (FHD)

FHD was calculated using the Shanon's index (refer 5.1 for equation) where p_i now refers to the proportion of foliage at that level. The evenness of distribution of foliage was calculated using Hill's Evenness index (Ludwig & Reynolds 1988)

3.3.4. STRUCTURAL VARIABLES

Bird species richness (BSR) values for summer and winter were correlated with habitat variables using Pearson's correlation (Norusis 1986).

3.3.5. HABITAT MODEL

Stepwise Multiple Regression analysis was used to understand the relationship of different habitat parameters with bird species richness (BSR). The stepwise model was used to evaluate the contribution of each habitat parameter in explaining the variability observed in BSR.

3.3.6. GUILDS

Bird species recorded on each transect were classified into guilds using the *a priori* procedure (Weins 1989). The natural history information required for the same was gleaned from Ali & Ripley (1986). Intra - seasonal differences in guilds were analysed using Friedman's two way analysis of variance. Chi - square test was used to check for significant inter seasonal differences in avian guild species composition in each habitat.

3.3.7. EFFECT OF DISTURBANCE

To evaluate the effect of disturbance on bird community, both the disturbed and undisturbed nulls were compared for proportion of Tramp species (Beehler *et al.* 1987).

SPSS PC+ (Norusis 1986) was used for computing both parametric and nonparametric statistics.

CHAPTER 4 RESULTS

4.1. BIRD SPECIES DIVERSITY (BSD)

The BSD indices show no clear difference. Despite sampling intensity having been greater in the undisturbed nulla, it has the same diversity values (refer Table 2) as that of the disturbed nulla in winter and only slightly more in summer.

4.2. BIRD SPECIES RICHNESS (BSR)

Rarefaction curves show that the undisturbed nulla has the greater Bird species richness (Fig.3 & 4).

BSR values show that the riparian areas have a greater species richness as compared to the deciduous area. This is true even of the riparian scrub area which is not as structurally diverse (Fig.4) as the deciduous area.

4.3. FOLIAGE HEIGHT DIVERSITY (FHD)

FHD indicates the volume of foliage at each level. FHD measures show that in winter the scrub area is structurally poor while in the summer the deciduous area is devoid of almost all foliage (Fig.3). The distribution of foliage among the vertical levels in all the habitats (except for the undisturbed nulla) is more even in winter than in summer. The leaves are shed more from the upper layers than the lower layers in the riparian areas. In the disturbed area, the lower layer is not

as thick as in other riparian areas.

4.4. STRUCTURAL VARIABLES

Correlation of the BSR values with the vegetation structural variables shows that BSR is very highly correlated with canopy cover in winter while in summer FHD is the most significant variable (Table 4).

4.5. THE HABITAT MODEL

Any community study takes on a synthetic approach as the number of parameters is otherwise difficult to handle. The conjunction of many parameters can confound results. There is always the risk of committing a type I error - results that are statistically significant may just be biological nonsense.

Stepwise multiple regression procedure using SPSS (Norussis 1986), for BSR in winter as the dependent variable and FHD in winter, canopy cover in winter, tree density, tree species, basal area, canopy height and canopy difference for winter data yielded the following regression equation with standard errors

MODEL I

$$\text{BSRW} = 0.1105(+ 0.0022)\text{CCW} + 0.497(+ 0.0367)\text{C.DIF} + 14.641(+ 0.02)$$

$$R^2 = 0.999 \quad \text{Adjusted } R^2 = 0.998 \quad P=0.0006$$

Removing deciduous area from the data, model for riparian areas
Model II

$$\begin{aligned} \text{BSRW}_r &= 6.75342(\pm 0.79307)\text{FHDW} + .869(0.003607)\text{CCW} \\ &\quad + (-0.006126)(\pm 0.056207) \\ R^2 &= 0.9999 \quad \text{Adjusted } R^2 = 0.99987 \end{aligned}$$

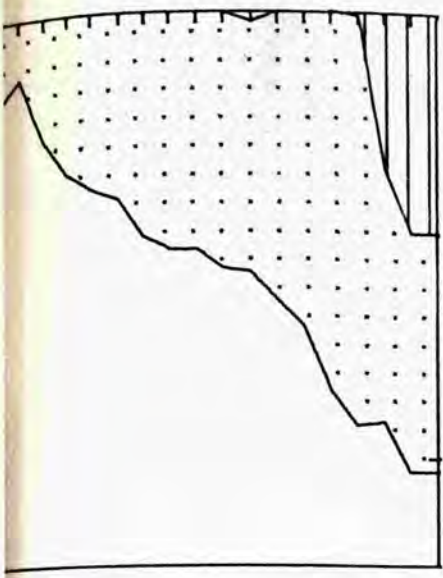
However the models obtained for summer are quite different.
The general habitat model uses only a simple regression equation
Model III

$$\text{BSRS} = 3.7256(\pm 0.5509)\text{FHDS} + 15.07696(\pm 1.307814)$$

After removing the deciduous forest from the analysis
the following regression equation was attained for summer.
Stepwise multiple regression was used with BSR summer (BSRS) as
the dependent variable and FHD summer (FHDS), canopy cover summer
(CCS), Tden, Tsp, BA, Cht and Cdif with standard errors.

MODEL IV

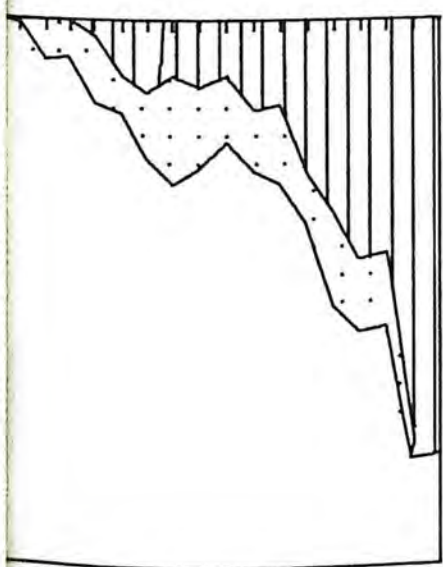
$$\begin{aligned} \text{BSRS} &= 10.7746(\pm 0.1747)\text{FHDS} - 16.311(\pm 1.9537)\text{Tden} \\ &\quad + 0.0071(\pm 0.10348) \\ R^2 &= .9999 \quad \text{Adjusted } R^2 = .996 \end{aligned}$$



DRY DECIDUOUS



DISTURBED NULLA

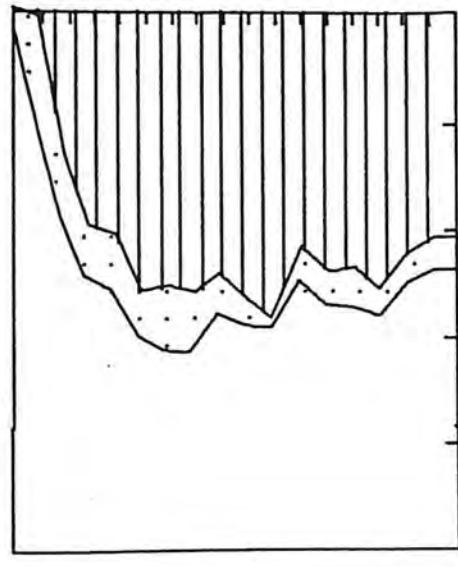


SCRUB

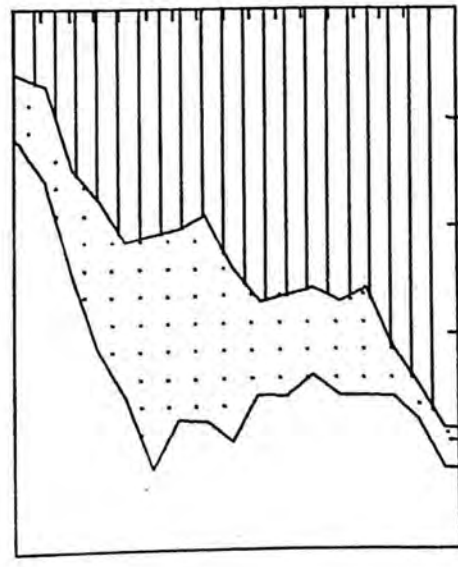
Hieght on Y-axis:
 0.25, 0.5, 1, 3, 4, 5
 6, 7, 8, 10, 12, 15
 25 & 30m

⋯ Foliage Profile
 in winter

|||| Foliage Profile
 in summer



UNDISTURBED NULLA



FLOOD PLAIN

Fig.3 Seasonal Foliage Profile

FIG. 4 RAREFRACTION CURVES FOR WINTER

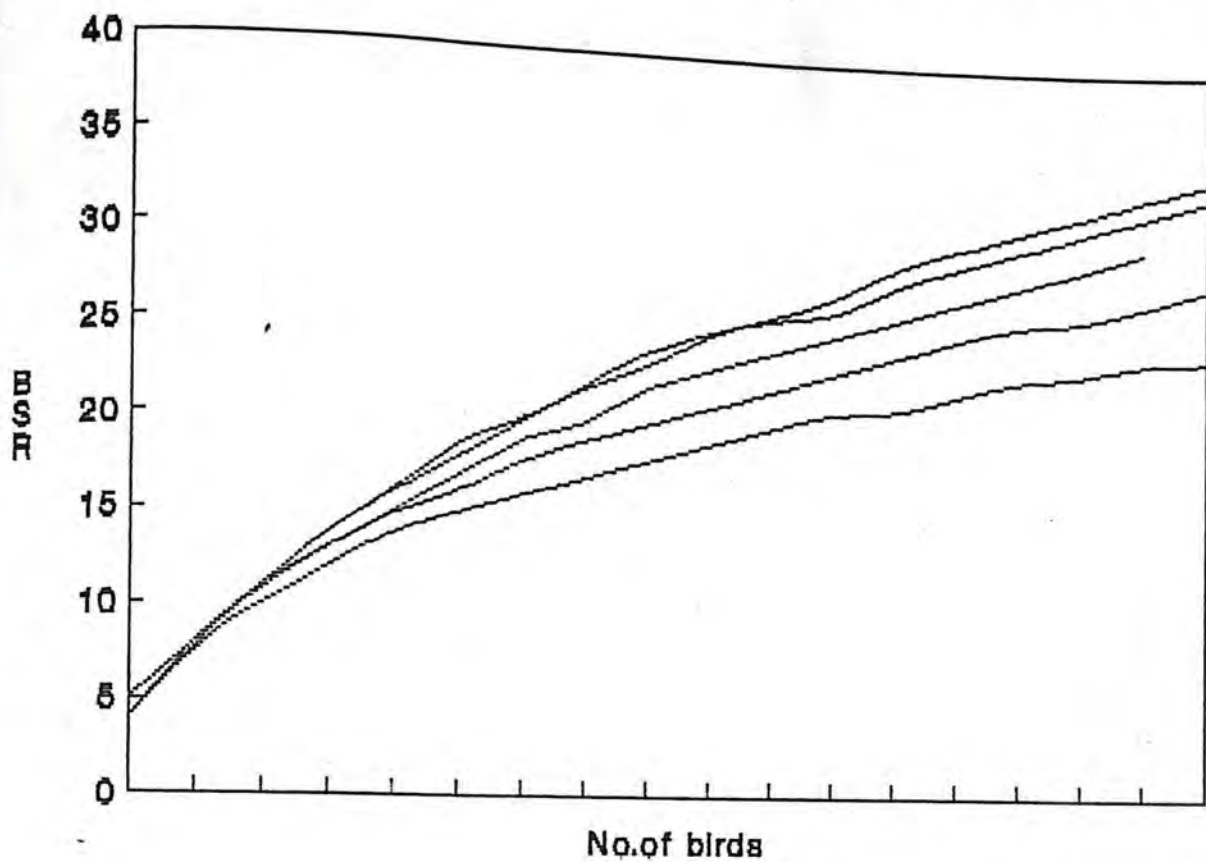
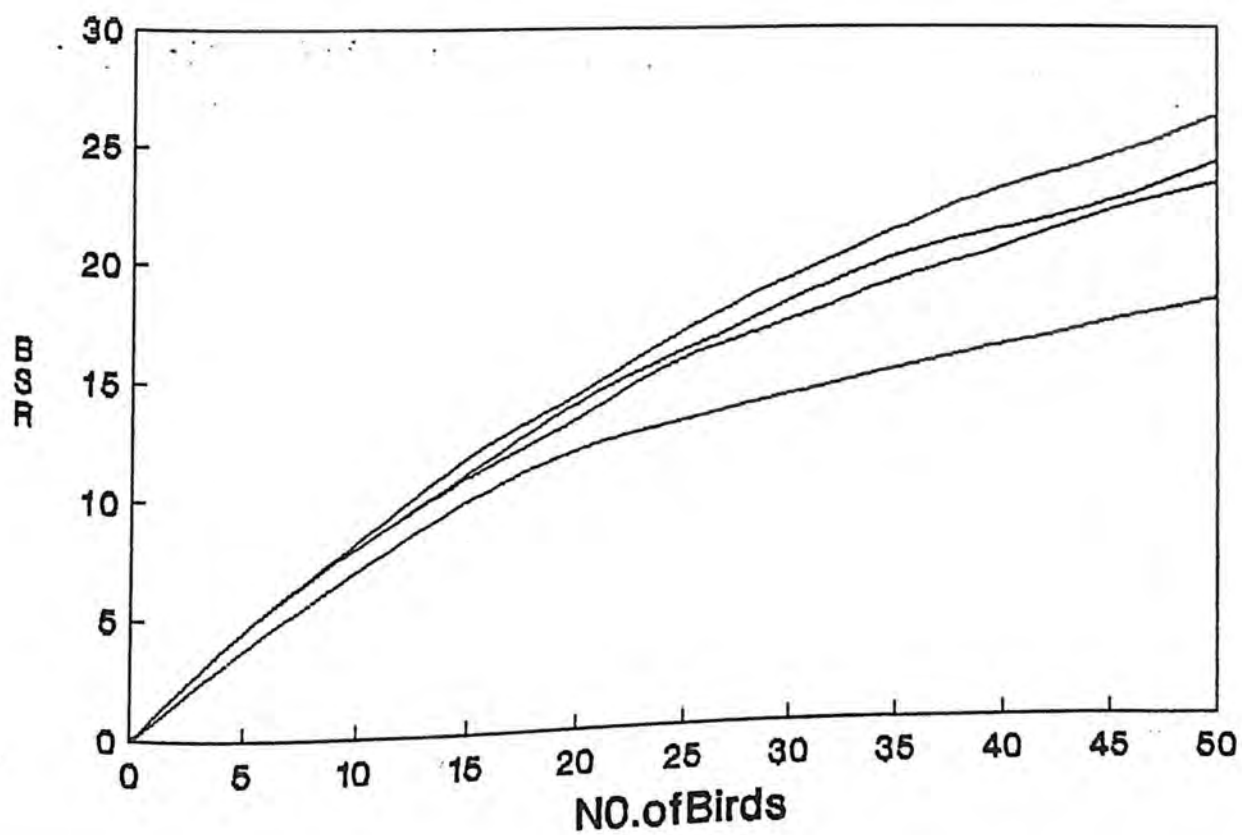


FIG. 5 RAREFRACTION CURVES FOR SUMMER



4.6. GUILD STRUCTRE

Freidman's two way analysis of variance for guild species structure and composition did not show any significant difference between habitats.

The only apparent sign of disturbance in the disturbed riparian areas was the excessive number of trash species such as Mynahs (*Sturnidae*), Crows (*Corvidae*) and redvented bulbuls (*Pycnonotus kafer*)

Table 1. Bird species diversity during November 1992 to May 1993 at Bori WLS, for the various habitat types calculated using Shanon's index

HABITAT	BSDW (winter)	BSDS (summer)
Floodplain	3.26	3.48
Scrub	2.81	3.03
Undisturbed nula	3.17	3.13
Disturbed nula	2.81	3.46
Deciduous area	3.13	2.82

Table 2. Bird species richness (BSR) during November 1992 to May 1993 at Bori WLS, for the various habitat types using rarefaction

HABITAT	Winter	Summer
Floodplain	23	26
Scrub	19	24
Undisturbed nula	25	24
Disturbed nula	25	26
Deciduous area	21	18

Table 3. Foliage height diversity calculated using Shanon's index and evenness using Hill's index

HABITAT	WINTER	SUMMER
FLOODPLAIN	3.26	3.48
SCRUB	2.81	3.03
UNDISTURBED NULLA	3.17	3.46
DISTURBED NULLA	3.13	2.82
DECIDUOUS AREA	3.13	2.82

Table 4. Correlation between bird species richness (BSR) and vegetation variables . significance * =.01; ** = .001

	BSRW	BSRW _r	BSRS	BSRS _r
FHDW	0.84	0.99**	-	-
FHDS	-	-	0.97*	0.968*
CCW	0.97*	0.94**	-	-
CS	-	-	0.72	0.71
TDEN	0.81	0.95**	0.75	0.76
TSP	0.69	0.98**	- 0.17	- 0.17
BA	0.72	0.72*	0.58	0.58
CHT	0.08	0.78*	0.14	0.14
CDIF	0.48	0.97*	0.7	0.70

BSRW= BSR winter; BSRW_r = BSR winter without deciduous area; BSRS = BSR summer; BSRS_r = BSR summer without deciduous area; FHDW = FHD in winter; FHDS = FHD summer; CCS = Canopy Cover summer; CCW = Canopy Cover winter; TDEN = Tree density; TSP = Tree species; BA = Basal area; CHT = canopy height; CDIF = Canopy difference.

Table. 5. The guilds and the number of species within for each habitat in winter.

	D	SC	UND	FP	DIST
Carnivore	2	1	2	2	4
Fruit/Seed	3	3	1	2	3
Fruit / Insectivore'	2	1	2	1	1
Granivore	1	1	2	2	3
Insectivore terrestrial	3	5	6	9	5
Insectivore bark	4	0	2	3	2
Insectivore sally	4	3	7	7	7
Insectivore leaf	7	4	4	7	7
Wader	0	3	5	0	2
Omnivore	7	4	3	5	8
Nectarivore	1	1	1	1	1
Scavenger	1	0	0	0	1
Frugivore	1	2	2	2	3
Piscivore	0	1	3	3	3
TOTAL	36	28	40	45	50

D = deciduous ; SC = scrub ; Und = undisturbed nulla ;
 FP = flood plain ; Dist = disturbed nulla.

Table. 6. The guilds and the number of species within for each habitat in summer.

	D	SC	Und	FP	Dist
Carnivore	2	5	1	2	2
Fruit/Seed	2	1	2	2	2
Fruit / Insectivore	0	1	1	1	1
Granivore	2	0	1	3	2
Insectivore terrestrial	2	4	4	6	4
Insectivore bark	0	2	0	4	3
Insectivore sally	3	6	2	6	6
Insectivore leaf	4	1	7	6	11
Wader	0	1	5	2	1
Omnivore	9	6	4	8	7
Nectarivore	1	1	0	2	2
Scavenger	0	0	0	0	0
Frugivore	1	0	3	1	5
Piscivore	0	1	3	2	2
TOTAL	26	23	33	43	47

D = deciduous ; SC = scrub ; K = undisturbed nulla ;
 FP = flood plain ; BH = disturbed nulla

CHAPTER 5 DISCUSSION

In the results, I have mentioned the patterns that I have observed in the riparian areas. In this chapter I shall try to reason why they occur and what determines them; also whether these patterns conform to other studies or not. Due to lack of any investigative work done on avian communities in riparian ecosystems in India, I can only resort to comparisons from the New World.

5.1. BIRD SPECIES DIVERSITY (BSR):

Though measurement of diversity is the most often repeated procedure in community ecology, it is still not clearly defined or delineated (Magurran 1988). Diversity measures commonly used for comparative studies are at fault - the area effect, sampling intensity and number of individuals can cause severe biases (James & Rathbun 1981, Magurran 1988, Weins 1989).

If we look at the BSD values (Table 1), then it would seem that scrub and disturbed areas are the lowest in diversity in winter while in summer the deciduous area stands the lowest. The disturbed nulla may truly have a low BSD in winter but the low values of BSD in scrub in summer and in the deciduous area in summer could also be attributed to inconsistency in sampling (i.e. length of transect). BSD values increase with sampling effort even if habitats are assumed to be homogenous (Magurran 1988).

5.2. BIRD SPECIES RICHNESS

Using rarefaction (James & Rathbun 1981), standardised the data to a known number of individuals thus overcoming the area effect and the sampling discrepancies. With Rarefaction the species abundance patterns have become more clear (Table 2). Deciduous forest now has a diversity lower than all the riparian areas except for scrub. These observations agree with other studies in riparian areas (Knopf 1985, Finch 1989). Why does this occur? The only clue to the answer lies in the resource availability. A short study cannot quantify all the variables necessary to study resource use patterns. However it can indicate trends and thus enable me to hypothesize on the probable effect of resource availability.

Riparian vegetation in lowland areas such as Bori WLS tends to be structurally diverse (Knopf 1985, Finch 1989). The resource base offered is wide. Insect abundance is more in the riparian areas than in the deciduous area (Meehan *et al.* 1977). Anderson (1970) highlighted that bird migration often coincide with an increase in the number of insects. Most of the migrants are insectivores (eg. flycatchers) and there is an upsurge of butterflies and cicadas at the same time. Insect abundance is related to the availability of density vegetation which is important to the invertebrates in their larval stages. Since insect availability in turn affects insectivores and their spatial and temporal distribution patterns (Hutto 1981), it could be a major factor influencing BSR in riparian areas. Extensive branching of riparian species such as *S. cumini* allows for more

substratum for sallying insectivores. The availability of benthic and invertebrates influences kingfishers as does the availability of overhanging branches for perches. Another extra guild comes into the picture in riparian areas - the waders who prey on macroinvertebrates. Birds such as sandpipers, storks and herons are exclusive to riparian areas.

Fruiting trees are more in the riparian areas (Rodgers 1990). This affects the densities of the frugivorous guild both the obligate frugivores such as hornbills and yellow legged green pigeons and facultative frugivores like parakeets. Flowering of *Mangifera indica* can increase insect abundance and consequently affect the BSR.

Migrants prefer riparian areas to upland sites (Knopf 1985). Therefore they also increase the species diversity of the riparian areas. The reason behind this maybe that riparian areas offer more "free" niches for the migrants to occupy simply because they are structurally more diverse (Table 3 & Fig.3). Migrants tend to be specialized in their foraging tactics though they are adaptable to sudden flushes of food. This is just a tactic to avoid competition from resident species (Anderson and Ohmart 1977, Herrera 1985).

Also with the onset of summer, deciduous forests in Bori are of all foliage (Refer fig.3). This may affect the insectivores. They would migrate to riparian areas where there is still some amount of foliage (Hutto 1981, Hererra 1985). The phenology of riparian areas have to be given more attention to substantiate this argument. Seasonal increase of BSR in riparian areas can be explained by migration and also the leaf fall

Another reason for the increased BSR maybe the ecotonal effect. The riparian community-deciduous forest interface increases the horizontal habitat diversity which has been shown to increase BSR (Roth 1976).

BSR could also be increased by the floristic composition of the riparian area itself (Rice et al. 1984). In the disturbed nulla there is an increased patchiness of habitat created by the nursery, the human dwellings and the exotic plantations. Flowering of *Eucalyptus* can cause an upsurge of bird densities.

Instead of just mere hypothesising let us look into the habitat variables themselves and how and why birds respond to them

5.3.THE STRUCTURAL VARIABLES:

When BSR was correlated to vegetational variables we get canopy cover and canopy height difference as the two most significant variables in winter(Table 4). but summer shows FHD as the most significant variable. When the summer variables for deciduous area were removed, BSR showed high correlation also with canopy cover, tree density, tree species and canopy height difference.

5.3.1.CANOPY COVER:

My work shows a high correlation between Canopy cover and BSR. Canopy cover is one variable that is consistently shown

in most avian studies as being correlated to BSR in some way (Karr & Roth 1971, Willson 1974, Beedy 1981, James & Wamer 1982, Verner & Larson 1989). Canopy cover is directly related to foliage volume and the crown cover.

Curvilinear relations with canopy cover indicate that there may be some optimum canopy cover for BSR (Karr & Roth 1971, Willson 1974) i.e. after a certain level canopy cover may actually affect BSR negatively. Daniels (1989) had shown that BSR in a tropical semievergreen forest in the South India is negatively correlated to the canopy thickness but is positively correlated to heterogeneity of the habitat. Beedy (1981) had shown the same in a temperate forest. There are several reasons attributed to this. One is that as the canopy cover increases, it discourages growth of understorey depriving the habitat of one whole substratum. Another factor which limits insectivores is light conditions (Kalcenik 1979). As canopy cover increases light conditions decrease. If canopy cover is too less it may constrain the insectivores at the upper strata of the habitat. There may be too much light or too less insects.

Roth (1976) felt that a discontinuous canopy created more edges for feeding. Concurring with the last statement is not possible until I examine my data more closely for spatial patterns of species in the community that I studied.

5.3.2. FOLIAGE HEIGHT DIVERSITY

In summer if data for all habitats are pooled together, then BSR shows a high correlation with only FHD. Keeping in mind

the drastic changes that take place in deciduous area, it was removed from the data set. The BSR in the riparian areas in summer showed positive correlations with FHD, Canopy cover, Tree density and Canopy Height.

Why must FHD play such an important role in summer and not in winter and why at all does it figure as such an important factor in influencing BSR. Studies in temperate areas show the BSR-FHD to be linearly correlated (Willson 1974; Finch 1977; Karr & Roth 1971; Verner & Larson 1989). Some studies have disproved this relationship (Terboggh 1985; Weins & Rotenberry 1981). Though there is an immense amount of work on this structural aspect, the process behind the pattern is still not clear. Despite the high statistical significance, FHD may be a misnomer since it is just a function of canopy height, foliage volume and evenness of distribution of foliage among the various levels. Verner & Larson (1989) found a simple correlation between BSR and FHD but found canopy cover to be a better indicator of BSR.

In the regression analysis FHD accounts for 99% of the variation that occurs in summer BSR. Willson (1974) had shown that similarly structured communities need not necessarily support similar communities. This implies that FHD is not the only factor that birds respond to. Hence quantification of other structural and floristic variables is very essential.

Areas which are structurally diverse - the nullahs show consistently high values for BSR. A look at the actual number of species would reveal that the number of species recorded in each habitat has actually undergone a decline. This indicates

that there are more individuals in each species contributing to the BSR values than there the absolute number of species themselves. Intra specific competition would be more for similar resources.

Pearson (1975) had concluded that FHD- BSD correlations show up when there is more competition in a community. A more complex foliage would ensure that competition can be effectively avoided. I feel that FHD is of importance to migrant species as they are more of specialists in their foraging strategies though they are generalists in terms of their diet (Herrera 1978). The choice of foraging substratum would be crucial to them for avoiding competition from the resident species especially in case of a resource crunch. A possible bias with FHD values is that it increases with the evenness of distribution of foliage (Rice et al 1985). In my study except for the Disturbed area, there is actually a decrease in evenness of foliage distribution with leaves being shed from the top canopy. The aforesaid bias being removed, we can state with some certainty that FHD has some role to play in riparian community dynamics.

Another major factor is that with leaf fall in summer (refer Fig.3), foliage does become a limiting factor. Rice et al (1983) had recorded resource crunch and severe inter specific competition during autumn. My observations suggest the same could happen during the summer months. Use of other niche overlap indices would perhaps reveal the extent of competition.

5.3.3. TREE DENSITY AND TREE SPECIES

This is one aspect of vegetation that has not been given enough importance. James (1971) using multivariate statistics had shown that the most important variables that effected BSR were CC, Cht and tree density. Willson (1974) had also shown a linear correlation between BSR and FHD. She had suggested that tree density increases the patchiness of the environment. If this patchiness were to be looked at in the view of just the food supply or availability of foraging substrates we would lose out on the other microhabitat resource use patterns such as perch sites and also important nest site availability in riparian areas (Best & Stauffer 1980). There is proof that birds prefer certain combinations of plant species and their preference plays a more important role than their avoidance (Rice *et al.* 1984).

Are structural variables as important as they are made out to be? My study would reply in the affirmative. A seasonal pattern cannot be denied. The major hitch with any community study is that it merges too many species and studies them in terms of vegetation variables. The subtlety of species habitat relationships is lost in any such clumping of different species. Even a simple measure such as BSR obscures the "quality" of species found. Species compositions of any community are very crucial to its dynamics. Techniques such as multivariate analysis combined with principal components analysis can identify groups of species that respond to certain combinations of habitat variables (Finch 1985).

5.4. SEASONALITY

Most avifaunal community work considers species - habitat relationships only in space and not with respect to time. Seasonal patterns are available for only a few studies.

From the trend in BSR values as well as the BSR - habitat relationships it is obvious that there is a drastic change in avian community dynamics. Studies in the Lower Colorado valley have indicated the same (Rice *et al.* 1986).

One other major event that shows up in summer is the breeding season of most birds on the Indian subcontinent (Ali & Ripley 1986). Birds tend to show up more due to displays and courtship, causing a significant increase in counts (eg. Magpie robin personal observation). Breeding season requirements are very different and competition both within and between communities is more often for other resources such as nest sites, display areas, females, nest building material. Inter specific interactions with respect to these have also to be studied.

Community dynamics change and these changes correspond to changes in vegetation structure.

5.5. Guild

Guild patterns do not indicate much. There is an increase in the number of species in the carnivore guild in the scrub area. This could be attributed to the breeding season because most observations show them in courtship displays.

There is also an increase in the omnivorous guild.

Being generalists in diet is perhaps a response to any patches or flushes of food that may be found.

The reason for decrease of sally insectivores decreasing in summer may be that too much foliage is lost from the upper strata again restricting insectivores.

5.6. THE HABITAT MODEL

There are only a few attempts at creating any habitat model for riparian areas despite their importance to wildlife (Anderson & Ohmart 1985, Rice *et al* 1986, Dobkin & Wilcox 1986).

The BSR for winter is accounted for by variation in Canopy Cover and Canopy difference. While in summer FHD explains 90 % of the variation that occurs.

How does the regression equation developed help a manager? If he wanted to see what effect any management activity could have on a riparian area, he would have to only substitute iterative values for the vegetation variables in the equation to simulate BSR with a certain degree of certainty.

To be even more specific to see how the management measures would affect a particular species discriminant analysis can be used to generate models which are species specific (Rice *et al.* 1986)

One area to which the model can probably be applied Practically is the extensive bunding programme in Bori WLS which often causes changes in streamside vegetation. BSR can be generated by the model can be used to assess any negative or

positive impacts.

A major pitfall with the model is that the period of study is too short to comprehensively examine overall patterns of a bird community. However, testing of this model could bring out its robustness and relative accuracy in riparian areas of Bori wild life Sanctuary. It is too ambitious to expect a biological model to be 100% accurate. A margin of error of about 30% can be allowed (Rice et al. 1986).

Another major problem with the study is also that it cannot predict wildlife values. BSR in the disturbed nullah may be high but a careful examination of the of the species found would show that they are of low conservation values and are those commonly associated with human habitations (Daniels 1986).

The need for studying relative species abundance and developing species specific models for each species in Riparian areas, especially the insular ones (eg. waders, riparian ground feeders) cannot be over emphasized.

CONCLUSIONS

1. Riparian bird community patterns show a seasonal difference.
2. Riparian bird community patterns are related to vegetation structure and any changes that occur therein.
3. Bird species richness in riparian areas is higher than that of the deciduous forests.
4. Bird species richness in riparian areas is correlated with canopy cover and canopy difference in winter but is very highly correlated to foliage height diversity in summer.
5. Habitat models were created for summer and winter. These models can help the management assess impacts of any management activity on riparian areas

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APPENDIX I

LIST OF BIRDS FOUND IN BORI WILDLIFE SANCTUARY
(compiled by Aswini Pai Wildlife Institute of India.)FAMILY: PHALACROCORACIDAE

Little cormorant	<i>Phalacrocorax niger</i>
Darter	<i>Anhinga rufa</i>

FAMILY: ARDEIDAE

Grey heron	<i>Ardea cinerea</i>
Little green heron	<i>Ardeola striatus</i>
Pond heron	<i>Ardeola grayii</i>
Cattle egret	<i>Bubulcus ibis</i>
Large egret	<i>Ardea alba</i>
Smaller egret	<i>Egretta intermedia</i>
Little egret	<i>Egretta garzetta</i>
Night heron	<i>Nycticorax nycticorax</i>
Chestnut bittern	<i>Ixobrychus cinnamomus</i>

FAMILY: CICONIIDAE

Openbilled stork	<i>Anastomus oscitans</i>
White necked stork	<i>Ciconia episcopus</i>
Black stork	<i>Ciconia nigra</i>
Black necked stork	<i>Ephippiorynchus asiaticus</i>

FAMILY: THRESKIORNITHIDAE

White ibis	<i>Threskiornis aethiopica</i>
Black ibis	<i>Pseudibis papillosa</i>
Glossy ibis	<i>Pseudibis falcinellus</i>
Spoon bill	<i>Platalia leucorodia</i>

FAMILY: ANATIDAE

Barheaded goose	<i>Anser indicus</i>
Ruddy shelduck	<i>Tadorna ferruginea</i>
Pintail	<i>Anas acuta</i>
Common teal	<i>Anas crecca</i>
Shoveller	<i>Anas clypeata</i>
Redcrested pochard	<i>Netta rufina</i>

FAMILY: ACCIPITRIDAE

Blackwinged kite	<i>Elanus caeruleus</i>
Honey buzzard	<i>Pernis ptylorynchus</i>
Goshawk	<i>Accipiter gentilis</i>
Shikra	<i>Accipiter badius</i>
Sparrow-hawk	<i>Accipiter nisus melaschista</i>
Whiteeyed buzzard-eagle	<i>Butastur teesa</i>
Crested hawk-eagle	<i>Spizatus cirrhatus cirrhatus</i>
Indian longbilled vulture	<i>Gyps indicus</i>
Indian whitebacked vulture	<i>Gyps bengalensis</i>
Scavenger vulture	<i>Neophron percnopterus</i>
Marsh harrier	<i>Circus melanoleucos</i>
Crested serpent eagle	<i>Spilornis cheela</i>
Osprey	<i>Pandion haliaetus</i>

FAMILY: PHASTANIDAE

Grey partridge
Jungle bush quail
Red spurfowl
Red junglefowl
Grey junglefowl
Common peafowl

Francolinus pondicerianus
Perdicula asiatica
Gallioperdix spadicea
Gallus gallus
Gallus sonneratii
Pavo cristatus

FAMILY: RALLIDAE

White breasted waterhen

Amaurornis phoenicurus

FAMILY: RECURVIROSTRIDAE

Blackwinged stilt
Avocet

Himantopus himantopus
Recurvirostra avocetta

FAMILY: BURHINIDAE

Stone curlew

Burhinus oedicnemus

FAMILY: CHARADRIIDAE

Redwattled lapwing
Spurwinged lapwing
Little ringed plover
Redshank
Greenshank
Green sandpiper
Wood sandpiper
Common sandpiper
Little stint

Vanellus indicus
Vanellus spinosus
Charadrius dubius
Tringa totanus
Tringa nebularia
Tringa ochropus
Tringa glareola
Tringa hypoleucos
Calidris minuta

FAMILY: LARIIDAE

Indian river tern
Blackbellied tern
Indian skimmer

Sterna aurantia
Sterna acuticanda
Rynchops albicollis

FAMILY: COLUMBIDAE

Yellow legged green pigeon
Rufous turtle dove
Indian ring dove
Spotted dove

Treron pnoenicoptera
Streptopelia orientalis
Streptopelia decaocto
Streptopelia chinensis

FAMILY: PSITTACIDAE

Alexandrine parakeet
Rose ringed parakeet
Blossomheaded parak.

Psittacula eupatoria
Psittacula krameri
Psittacula cyanocephala

FAMILY: CUCULIDAE

Common hawk-cuckoo
Indian banded bay cuckoo
Koel
Crow pheasant

Cuculus varius
Cacomantis sonneratii
Eudynamys scolopacea
Centropus sinensis

FAMILY: STRIGIDAE

Collared scops owl
Brown fish owl
Forest eagle owl
Jungle owlet
Spotted owlet

Otus bakkamoena
Bubo zeylonensis
Bubo nepalensis
Glaucidium radiatum
Athene brama

FAMILY: CAPRIMUGILIDAE

Common indian nightjar
Longtailed nightjar

Caprimulgus asiaticus
Caprimulgus macrurus

FAMILY: ALCEDINIDAE

Lesser pied kingfisher
Common kingfisher
Storkbilled kingfisher
Whitebreasted kingfisher

Ceryle lugubris
Alcedo althis
Pelargopsis capensis
Halcyon smyrnensis

FAMILY: MEROPIDAE

Chestnutheaded bee eater
Green bee eater
Bluebearded bee eater

Merops leschenaulti
Merops orientalis
Nyctyornis athertoni

FAMILY: CORACTIDAE

Indian roller

Coracias benghalensis

FAMILY: UPUPIIDAE

Hoopoe

Upupa epops

FAMILY: BUCEROTIDAE

Common grey hornbill
Malabar pied hornbill

Tockus birostris
Anthracoceros coronatus

FAMILY: CAPITONIDAE

Large green barbet
Crimsonthroated barbet
Crimsonbreasted barbet

Megalaima zeylonica
Megalaima rubricapilla malabarica
Megalaima haemacephala

FAMILY: PICIDAE

Small yellow naped
woodpecker
Lesser goldenbacked
woodpecker
Fulvous breasted pied
woodpecker
Greycrowned pygmy
woodpecker
Yellow fronted pied
woodpecker
Black backed
woodpecker

Picus chlorolophus chlorigaster
Dinopium benghalense
Picoides macei
Picoides nanus
Picoides mahrattensis
Chrysocolaptes festivus

FAMILY: ALAUDIDAE

Ashycrowned finch lark
Rufoustailed finch lark

Eremopterix grisea
Ammomanes phoenicurus

FAMILY: HIRUNDINIDAE

Plain Sandmartin
Wire tailed swallow
Indian Cliff swallow

Riparia plaudicola
Hirundo smithii
Hirundo fluvicola

FAMILY: LANIIDAE

Grey shrike
Bay backed Shrike
Rufous backed Shrike
Brown Shrike

Lanius cubitus
Lanius vittatus
Lanius collurie
Lanius cristatus

FAMILY: ORIOLIDAE

Golden Oriole
Blacknaped Oriole
Blackheaded Oriole

Oriolus oriolus
Oriolus chinensis diffusis
Oriolus xanthornus

FAMILY: DICRURIDAE

Black Drongo
Whitebellied Drongo
Spangled Drongo
Greater Racket tailed
Drongo

Dicrurus adsimilis
Dicrurus caerulescens
Dicrurus hottentottus
Dicrurus paradiseus

FAMILY: ARTAMIDAE

Ashy Swallow-Shrike

Artamus fuscus

FAMILY: STURNIDAE

Grey headed Myna
" sub spp.
Brahminy Myna
Rosy Pastor
Pied Myna
Common Myna
Bank Myna
Jungle Myn

Sturnus malabaricus
Sturnus malabaricus blythi
Sturnus pagodarum
Sturnus roseus
Sturnus contra
Acridotheres tristis
Acridotheres ginginianus
Acridotheres fuscus

FAMILY: CORVIDAE

Indian Tree Pie
House Crow
Jungle Crow

Dendrocitta vagabunda
Corvus splendens
Corvus macrorhynchos

FAMILY: CAMPEPHAGIDAE

Pied Flycatcher Shrike
Common wood Shrike
Large Cuckoo Shrike
Scarlet Minivet
Small Minivet
Whitebellied Minivet

Hemipus picatus
Tephrodornis pondicerianus
Coracina novaehollandiae
Pericrocotus flemmeus
Pericrocotus cinnamomeus
Pericrocotus erythropygus

FAMILY: IRENIDAE

Common Iora
Goldenfronted Chloropsis
Goldmantled Chloropsis

Aegithina tiphia
Chloropsis aurifrons
Chloropsis hardwickii

FAMILY: PYCNONOTIDAE

Redwhiskered Bulbul
Redvented Bulbul
White Browed Bulbul

Pycnonotus jocosus
Pycnonotus cafer
Pycnonotus luteolus

FAMILY: MUSCICAPIDAE

SUBFAMILY: MUSCICAPINAE

Brown Flycatcher
Redbreasted Flycatcher
Little Pied Flycatcher
Tickell's blue Flycatcher
Verditer Flycatcher
Greyheaded Flycatcher
Whitebrowed fantail Flycatcher
Whitethroated fantail
Flycatcher
White throated fantail
Flycatcher
Paradise Flycatcher
Blacknaped Flycatcher

Muscicapa latirostris
Muscicapa parva
Muscicapa westermanni
Muscicapa tickelliae
Muscicapa thalassini
Culicicapa ceylonensis
Rhipidura aureola
Rhipidura albicollis

Rhipidura albicollis albogularis

Terpsiphone paradisae
Hypothymus azurea

SUBFAMILY: TIMALINAE

Spotted Babbler
Slatyheaded scimitar babbler
Rufousbellied Babbler
Yelloweyed Babbler
Common Babbler
Large grey Babbler
Jungle Babbler
Quaker Babbler

Pellorneum ruficeps
Pomatorhynchus ruficollis
Dumetia hyperthya
Chrysoma sinensis
Turdoides caudatus
Turdoides malcomii
Turdoides striatus
Alcippe poicephala

SUBFAMILY: SYLVINAE

Rufous fronted wren Warbler
Plain wren Warbler
Ashy wren Warbler
Jungle wren Warbler
Tailor bird
Thickbilled Warbler
Indian great reed Warbler
Lesser Whitethroat
Large crowned leaf Warbler
Franklin's wren Warbler

Prinia buchnanii
Prinia sulflava
Prinia socialis
Prinia sylvatica
Orthotonus sutoris
Acrocephalus aedon
Acrocephalus stentorus
Sylvia curruca
Phylloscopus occipitalis
Prinia hodgsonii

SUBFAMILY: TURDINAE

Magpie Robin
Black Redstart
Stone Chat
Pied bush Chat
Indian Robin
Blue rock Thrush
Malabar Whistling Thrush

Copsychus saularis
Phoenicurus occurus phoenicuroides
Saxicola torquata
Saxicola caprata
Saxicoloides fulicata
Monticola solitarius
Myophonus horsfieldii

FAMILY PARIIDAE

Grey tit	<i>Parus major</i>
Yellow cheeked tit	<i>Parus xanthogenys</i>

FAMILY SITTIDAE

Spotted Grey creeper	<i>Salpornis pilonotus</i>
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FAMILY: MOTACILLIDAE

Tree Pipit	<i>Anthus trivialis</i>
Paddy field Pipit	<i>Anthus novaeseelandiae</i>
Yellow Wagtail	<i>Motacilla flava</i>
Grey Wagtail	<i>Motacilla cineria</i>
White Wagtail	<i>Motacilla alba</i>
Large pied Wagtail	<i>Motacilla madraspatensis</i>

FAMILY: DICARIDAE

Thickbilled Flowerpecker	<i>Dicarum agile</i>
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FAMILY: NECTARINIDAE

Purple Sunbird	<i>Nectarinia asiatica</i>
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FAMILY: ZOSTEROPIDAE

White eye	<i>Zosterops palpebrosa</i>
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FAMILY: PLOCEIDAE

SUB FAMILY: PASSIRINAE

House Sparrow	<i>Passer domesticus</i>
Yellow Throated Sparrow	<i>Petornia xanthocollis</i>

SUB FAMILY: ESTILDINAE

White throated munia	<i>Lonchura malabarica</i>
White backed munia	<i>Lonchura striata</i>
Spotted munia	<i>Lonchura punctulata</i>
Black-headed munia	<i>Lonchura malaeca</i>

FAMILY: FRINGILLIDAE

Common Rosefinch	<i>Carpodacus erythrinus</i>
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FAMILY: EMBERIZIDAE

Grey necked bunting	<i>Emberiza buchanani</i>
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