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Birds of the man-made ecosystems: the plantations

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Abstract. One-hectare plots were sampled for bird species diversity in the Uttara Kannada district. These plots represented well-preserved evergreen/semievergreen forests, secondary moist deciduous forests showing different levels of degradation by man and plantations of teak, eucalypts and betelnut. It was found that the betelnut plantation and the evergreen semievergreen forests had the least bird species diversity of $H' = 2.58$ and 2.61 respectively. The eucalypt and teak plantations had $H' = 2.69$ and 2.92 respectively. In the secondary moist deciduous forests it ranged from 2.80–3.39. Despite the apparent increase in diversity in the man-modified vegetation types, it was found that there was a gradual displacement of the bird species composition from what was typical to the evergreen forests to those of more urban and scrubby habitats in these man-modified vegetation types. This was particularly so in the eucalypt plantation.

Keywords. Western ghats; birds; plantations

1. Introduction

Converting natural forests into plantations has been a practice for at least two centuries in south India. The western ghats have been quite exploited this way. Large patches of rubber (*Hevea braziliensis*), tea (*Camellia sinensis*), coffee (*Coffea* sp), cardamom (*Elattaria cardamomi*), betelnut (*Areca catechu*), teak (*Tectona grandis*), eucalypts (*Eucalyptus* spp), etc. have become permanent elements of the western ghats landscape today. This transformation of one vegetation type into another could have made the region less fit for one species making it more suitable for another as Schemske and Brokaw (1981) suggest of periodic disturbances in tropical forests. They state that, periodic disturbances can influence the abundance of a particular species of bird and thereby the community diversity.

The first impression that any of these plantations gives an observer is that the birds present in them are a result of influence by the neighbouring natural vegetation. This is particularly exaggerated in plantations that are fairly old and in the middle of natural forests where often many of the forest species like trogons, racket-tailed drongos, bronzed drongos, minivets and woodpeckers forage as mixed flocks (R J Ranjit Daniels, unpublished results). Some species of birds freely use these plantations for foraging and even breeding. The little scalybellied green woodpecker (*Picus myrmecophoneus*) has been reported as being 'partial' to the rubber plantations in south India (Ali and Ripley 1983). The little spiderhunter (*Arachnothera longirostris*) is almost always met with in betelnut plantations and banana plantations if they are near humid natural forests (R J Ranjit Daniels, unpublished results).

Controversial ideas such as monocultures leading to reducing species diversity, local extinctions of species, etc. are currently in vogue. Besides these controversial ideas often reaching the local people through various forms of news media, active voluntary movements such as the Appiko in Uttara Kannada have organised anti-

eucalypt rallies many a times. Scientific investigations on these matters therefore seemed important to us.

While it is difficult to quantify the extent of influence of any kind caused by this displacement of vegetation on the bird communities of the western ghats, it is relatively simpler to get answers to questions like what level of bird species diversity can a plantation support and how similar is the bird community to the adjacent natural forests? Our study tries to answer these two basic questions

2. Study area

The Uttara Kannada district (13 55'–15 32'N; 74 5'–75 5'E) Karnataka, India (in which the study was carried out) holds approximately 175 km of the western ghats within its political limits. The 250 cm of annual rainfall is chiefly distributed over 5 months, June–October. In altitude, the district ranges from sea level to about 1000 m above MSL. The study sites however were distributed over altitudes of less than 50 m to about 600 m. The plantations in this area are mainly betelnut, teak and eucalypts. The natural forests are of the evergreen/semievergreen type along the slopes and secondary moist deciduous towards the more even plateau east of the ridge. Together they cover about 80% of the district's total area of 10,200 km^2. These forests have been legally classified into reserved forests (maintained by the state), minor forests (nearer human habitations and left for their use) and 'Soppina bettas'. The 'Soppina bettas' are like the minor forests but maintained and used by the betelnut growing farmers to meet their leaf-manure requirement, thus they often have better tree growth than the minor forests. The trees on these are periodically cut to manure their betelnut plantations. The best forests are generally the reserve forests. Figure 1 shows the location of the study plots in which birds were sampled. Table 1 gives the localities with their corresponding vegetation types. The legal status of these forests have determined the condition of the vegetation and not the vegetation type itself. The betelnut plantations are distributed as patches over about 50% of the district. They are old, well-watered. The canopy is closed and continuous, often merging with adjacent natural forests. A multi-tiered system of cropping including banana, pepper, cardamom, cocoa, etc. has made this plantation structurally similar to the natural evergreen/semievergreen forests in the district. This land use practice has been the tradition for more than 200 years among the 'Havik brahmins'. The teak and eucalypt plantations which are distributed over 29 and 10% of the district respectively, are more open, without the structural complexity as in the betelnut plantations, drier (especially the eucalypt), and much younger. However, they often have dense undergrowth of thorny, secondary species of plants (Daniels 1989).

3. Methods

The Uttara Kannada district was broadly divided into two vegetation zones which is primarily based on the annual rainfall and the corresponding vegetation types (Pascal 1982, 1984, 1986). Thus we have the evergreen/semievergreen zone and the drier secondary/moist deciduous zone (figure 1).

Three plots, each one hectare (100 × 100 m) in size were laid per vegetation type.

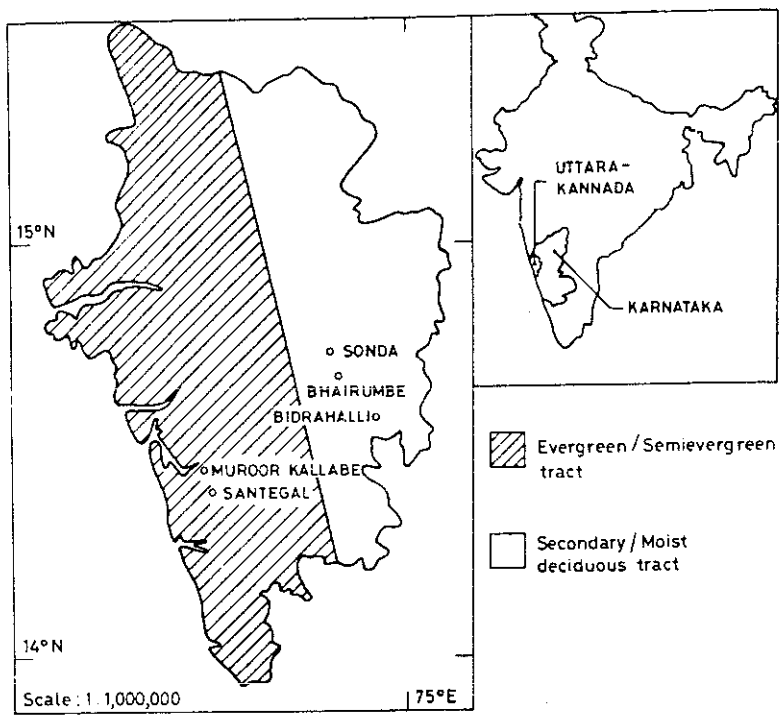

Figure 1. Map of Uttara Kannada showing the broad vegetation regimes and the location of the study plots

The 4 corners of these plots were permanently marked. Birds were sampled while walking over equally spaced transects (100 m long; 20 m intervals). This procedure was followed only to ensure that equal effort went into sampling all the study plots. All birds seen or heard within the plots and those flying at about 30 m height above ground over the plots were also counted. This height was fixed considering the average height of the canopy in all our study plots to be less than 30 m. All sampling was done between 08·00 and 10·00 h and between December and March when the birds are the most noisy and conspicuous. The 3 plots in each vegetation type were sampled on 3 consecutive days between December 1983 and March 1984 in the natural vegetation and then from January 1985 to March 1985 in the plantations. Since there were 3 plots to represent each vegetation type in the different localities, data from only one sample from each plot is used in this analysis. For calculating overall averages of bird species diversity corresponding to the two zones, more samples from one-hectare plots were used. Thus we have 37 samples from 21 one-hectare plots in the secondary/moist deciduous zone and 31 from 15 one-hectare plots in the evergreen/semievergreen zone. Some plots were sampled during other seasons also. The variation between samples from the same plot has been discussed elsewhere (Daniels 1989).

The species diversity of birds in each of the plant communities was estimated using the Shannon–Weaver diversity index,

$$H' = -\Sigma p_i \ln p_i,$$

where, p_i = the proportion of the ith species in the sample (Pielou 1975).

Table 1. The different vegetation types studied: their location and bird species diversity.

Locality	Latitude (N)	Longitude (E)	Altitude (m > MSL)	Vegetation type/ plant community	No. of bird species	No. of individuals	$-\Sigma p_i \ln p_i$
Santagal	14°23′	74°30′	375	Evergreen/semi-evergreen (reserve forest)	22	92	2·61
Bidrahalli	14°34′	74°55′	560	Secondary/moist deciduous (reserve forest)	22	93	2·85
Sonda	14°45′	74°49′	520	Secondary/moist deciduous (reserve forest)	26	130	2·80
Bhairumbe	14°41′	74°50′	520	Secondary/moist deciduous (minor forest)	42	258	3·30
Bhairumbe	14°41′	74°50′	520	Secondary/moist deciduous (Soppina betta)	41	154	3·39
Sonda	14°45′	74°49′	520	Teak (plantation)	27	95	2·92
Bidrahalli	14°34′	74°55′	560	Eucalyptus (plantation)	21	80	2·69
Muroor/Kallabe	14°27′	74°29′	50	Betelnut (plantation)	17	38	2·58

To check for similarity in bird species composition and abundance between the vegetation types, the Morisita–Horn similarity index,

$$C\lambda = 2\Sigma n(1, i) \times n(2, i)/(\lambda(1) + \lambda(2))N(1) \times N(2),$$

where, $\lambda(j) = \Sigma n^2(j, i)/N^2(j)$, $n(j, i)$ is the number of individuals of species i in sample j and $N(j)$ is the number of individuals in sample j, was used (Wolda 1981)

For calculating diversity and similarity indices, data from all the 3 hectares of each vegetation type were pooled for each locality

4. Results and discussion

4.1 *Bird species diversity*

The answer to the first question viz. what levels of bird species diversity a plantation can support is apparent in table 1. On the whole, the secondary/moist deciduous vegetation types have a higher bird species diversity than the evergreen forests. If averaged, the samples of birds from the moist deciduous zone have a higher diversity ($H' = 2{\cdot}8$) than those from the evergreen/semievergreen tract ($H' = 2{\cdot}56$). This difference is significant ($Z = 2{\cdot}057$; $n(1) = 37$; $n(2) = 31$; $P < 0{\cdot}05$) The secondary/moist deciduous zone is more heterogeneous spatially with a lot of second growth and openings (Daniels 1989). Such habitats are known to be more productive (Schemske and Brokaw 1981). Also apart from being secondary, these seem to be seral. This may be a further reason for the increased level of bird species diversity (Connell 1978). Except the *Eucalyptus* plantation ($H' = 2{\cdot}69$), the other vegetation types in the secondary/moist deciduous zone have diversities equal to or greater than the corresponding average viz. $H' = 2{\cdot}8$ (table 1). It appears from our results that there is an increase in bird species diversity when forests are disturbed (Daniels 1989). Connell (1978) relates high levels of diversity to disturbed conditions and lower levels to stability within the tropics. Among the 3 plantations viz betelnut, teak and *Eucalyptus*, the first two have diversity of bird species close to their respective vegetation zones. The teak and betelnut plantations which are often allowed to mature for at least 50 years, probably favour a community of birds to colonise, and even stabilize at levels of diversities close to what is appropriate to their respective vegetation zones (Daniels 1989). Frequent disturbances can prevent bird communities from establishing in any vegetation type. 'Establishing' need not necessarily mean 'to breed'. A species finding sufficient food in any habitat eventually becomes dependent on it. For example, a lot of forest birds such as racket-tailed, bronzed and haircrested drongos, lorikeets, blossom-headed parakeets, whiteheaded and hill mynas visit eucalypt trees for nectar. Nectar is an important source of sugar for a lot of otherwise insectivorous birds (Ali and Ripley 1983). The lower species diversity in the eucalypt plantation may be attributed to the fact that the plantation studied was young and cut every 5 years for pulpwood. It may also be true that a plantation of plants as exotic as the *Eucalyptus* may never be able to support a bird community with a level of species diversity equal to the natural forests in its neighbourhood.

4.2 *Similarity in bird species composition between the vegetation types studied*

Figure 2 answers the second question viz. how similar are the species of birds in the

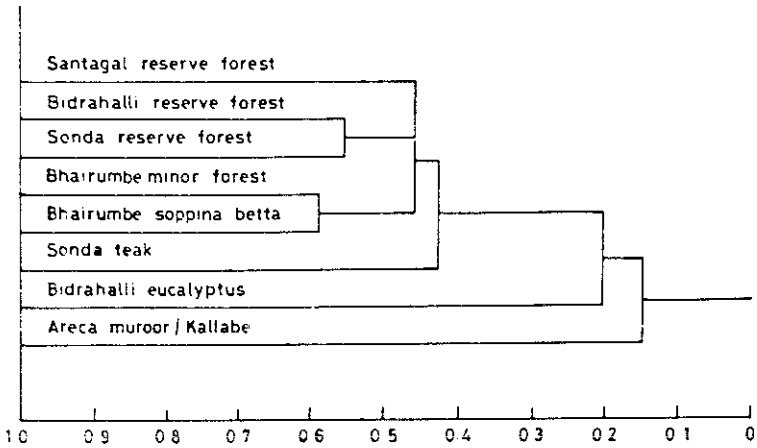

Figure 2. Dendrogram of similarity in the bird communities between the 8 vegetation types studied

different vegetation types? The 3 better preserved forests viz. Santagal, Bidrahalli and Sonda, in order of increasing disturbance, group together. Similarly, the 3 plantations. The minor forest and the 'Soppina betta' of Bhairumbe not only are the most similar, but also behave as transitions between the well-preserved natural forests and the man-made plantations. They are the most disturbed forests though not fully transformed as the plantations. They share species like *Hirundo daurica*, *Corvus macrorhynchos*, *Lanius cristatus*, *Oriolus oriolus*, etc. which are common urban birds, with the plantations and also birds like the *Irena puella* and *Nectarinia minima* with the better preserved forests (see appendix 1).

Tables 2–4 show how the bird species in each vegetation type have been characterized based on their food preference, habitat preference and geographic distribution over the country (see also appendix 1). This analysis has explicitly shown the differences in the species composition in the 8 vegetation types studied and how each compares with the overall avifauna of Uttara Kannada district.

As can be seen there is an apparent trend of change in the species composition from the natural forests to the completely man-made plantations. The birds preferring the humid evergreen forests are highly represented in Santagal (77·27%; table 2), the best forest among the 8 studied, and poorly represented in the *Eucalyptus* plantation (4·76%). On the contrary, birds of drier thicket habitats such as *Prinia hodgsoni* has invaded the eucalypt plantation. There is also a gradual increase in the proportion of generalist bird species (those which use more than one of the described habitat types) represented in the 8 vegetation types studied, starting with Santagal (22·73%) to the *Eucalyptus* plantation (76·19%).

Those species of birds which are predominantly frugivorous are found in a greater proportion in the evergreen/semievergreen forests of Santagal (45·45%) and the least in the betelnut plantation (5·88%). The *Eucalyptus* plantation has 14·29% (table 3). The reverse is true of the insectivorous birds. The betelnut and the *Eucalyptus* plantations have 76·47 and 71·43% respectively.

Table 4 shows that the endemic forms (species and subspecies) of birds of the western ghats are more in Santagal (45·45%) and the least in the *Eucalyptus*

Appendix 1. The complete list of birds identified during sampling in the 8 vegetation types with details of their geographic distribution (countrywide), food and habitat preferences and occurrence in the different vegetation types. For interpretation of codes see tables 1–4

Sl No*	Species	Geographic distribution	Habitat preference	Food	Occurrence in study area
42	*Ardeola grayii*	bcdefgh	c	a	3
44	*Bubulcus ibis*	bcdefgh	g	c	7
496	*Treron pompadora*	a	a	b	256
504	*Treron phoenicoptera*	b	b	b	45
511	*Ducula badia*	a	a	b	1
537	*Streptopelia chinensis*	bcdeg	g	e	4
542	*Chalcophaps indicus*	bcefgh	a	e	5
558	*Psittacula cyanocephala*	b	g	e	234567
566	*Loriculus vernalis*	bcdeh	g	e	12345678
582	*Cacomantis sonneratii*	bde	b	c	5
602	*Centropus sinensis*	b	g	c	4
692	*Chaetura sylvatica*	efg	a	c	1245
694	*Apus melba*	bcdefg	g	c	6
703	*Apus affinis*	bcd	f	c	34
707	*Cypsiurus parvus*	bcd	g	c	4
709	*Hemiprocne longipennis*	bde	b	c	34
750	*Merops orientalis*	bcde	g	c	4
768	*Tockus griseus*	a	a	b	56
775	*Anthracoceros coronatus*	bd	a	b	6
781	*Megalaima zeylanica*	a	g	b	124
785	*Megalaima viridis*	b	g	b	135
790	*Megalaima rubricapilla*	a	a	b	1
792	*Megalaima haemacephala*	bcde	g	b	45
804	*Micropternus brachyurus*	b	b	c	8
820	*Dinopium javenense*	b	a	c	1
825	*Dinopium benghalense*	a	g	c	234
852	*Picoides nanus*	bd	b	c	2456
856	*Hemicircus canente*	d	a	c	36
862	*Chrysocolaptes lucidus*	a	a	c	8
927	*Hirundo daurica*	bcd	g	c	57
922	*Hirundo fluvicola*	cf	b	c	34
949	*Lanius cristatus*	bdegh	g	c	457
953	*Oriolus oriolus*	bcdf	g	c	456
959	*Oriolus xanthornus*	bd	b	c	4
965	*Dicrurus leucophaeus*	bcdf	g	c	2567
967	*Dicrurus caerulescens*	bcd	b	c	47
971	*Dicrurus aeneus*	bdeg	a	c	1235
977	*Dicrurus paradiseus*	b	a	c	346
988	*Sturnus malbaricus*	a	a	c	4
1016	*Gracula religiosa*	a	a	b	147
1057	*Corvus macrorhynchus*	bd	g	f	45678
1065	*Hemipus picatus*	bd	a	c	45
1068	*Tephrodornis gularis*	a	a	c	36
1070	*Tephrodornis pondicerianus*	bde	b	c	4
1072	*Coracina novaehollandiae*	bd	g	c	457
1079	*Coracina melanoptera*	bde	g	c	45
1081	*Pericrocotus flammeus*	b	a	c	123456
1094	*Pericrocotus cinnamoneus*	a	b	c	3456
1100	*Aegithina tiphia*	b	b	c	457

Contd.

Appendix 1. *Contd*

1104	*Chloropsis aurifrons*	b	a	c	15
1107	*Chloropsis cochinchinensis*	bd	g	c	45
1109	*Irena puella*	begh	a	b	1345
1114	*Pycnonotus priocephalus*	a	a	b	14
1116	*Pycnonotus melanicterus*	a	a	b	1236
1120	*Pycnonotus jocosus*	b	g	b	4578
1128	*Pycnonotus cafer*	b	g	b	457
1144	*Hypsipetes indicus*	a	a	b	123
1149	*Hypsipetes madagascariensis*	b	a	b	13
1224	*Rhopocichla atriceps*	a	a	c	1
1264	*Turdoides striatus*	a	g	c	7
1390	*Alcippe poioicephala*	a	a	c	138
1407	*Muscicapa latirostris*	bdefh	g	c	25
1411	*Muscicapa parva*	bcf	g	c	567
1435	*Muscicapa pallipes*	a	a	c	23
1442	*Muscicapa tickelliae*	bcde	b	c	58
1460	*Terpsiphone paradisi*	bdf	g	c	268
1465	*Monarcha azurea*	bcde	g	c	568
1503	*Prinia hodgsoni*	bcd	b	c	7
1535	*Orthotomus sutorius*	bcd	g	c	7
1549	*Phragmaticola aedon*	bdeh	g	c	3
1556	*Acrocephalus dumetorum*	bcdef	g	c	137
1602	*Phylloscopus trochiloides*	bdefgh	g	c	1234567
1661	*Copsychus saularis*	bcd	g	c	458
1665	*Copsychus malabaricus*	a	b	c	3
1728	*Myiophoneus horsfieldii*	a	a	c	18
1734	*Zoothera citrina*	bd	a	c	8
1811	*Parus xanthogenus*	a	g	c	5
1838	*Sitta frontalis*	bdefg	a	c	235
1855	*Anthus trivialis*	bdf	b	c	6
1874	*Motacilla indica*	bcdefgh	g	c	57
1884	*Motacilla capsica*	bcdefgh	g	c	6
1892	*Dicaeum agile*	bcdef	b	b	4567
1902	*Dicaeum concolor*	b	a	b	23456
1907	*Nectarinia zeylonica*	bd	g	c	348
1909	*Nectarinia minima*	a	a	c	1248
1917	*Nectarinia asiatica*	bd	g	c	2456
1931	*Arachnothera longirostris*	beg	a	c	8
1933	*Zosterops palpebrosa*	bcdefg	g	c	8
1949	*Petronia xanthocollis*	bcdf	g	e	3456
1968	*Lonchura striata*	bd	g	e	8

[a]Serial numbers are those of Ali and Ripley (1983)

plantation (9 52%). It has been found that the birds of the western ghats, especially those of the evergreen/semievergreen forests are amongst the most geographically restricted of Indian birds (Daniels 1989). On these grounds, they have to be assigned a greater conservation value (Nature Conservancy 1983). Contrary to expectation, the 8 vegetation types have failed to show a marked representation of birds of the Assam region in them (table 4). This analysis is important as typicalness of species in a vegetation type makes it more valuable when it comes to conservation assessments (Usher 1986). The birds of the western ghats have a greater affinity to the birds of the northeast (Indo-Chinese region; Ali and Ripley 1983). The more this is expressed in a locality, the more typical the locality is.

Table 2. Habitat preference of the birds found in the 8 vegetation types studied (percentages).

Habitat	Santagal reserve forest	Bidrahalli reserve forest	Sonda reserve forest	Bhairumbe minor forest	Bhairumbe Soppina betta	Sonda teak	Bidrahalli eucalyptus	Muroor/Kallabe betelnut	Uttara Kannada
Humid forest ecosystem	77·27	40·91	53·85	21·43	26·83	37·03	4·76	35·29	21·04
Degraded/open moist forest with grass etc.	--	9·1	11·54	23·81	17·07	14·81	19·05	11·76	12·21
Freshwater marshes	—	—	3·8	—	—	—	—	—	9·35
Marine/estuarine	—	—	—	—	—	—	—	—	3·64
Dry forests with degradation/scrub	—	—	—	—	—	—	—	—	12·47
Urban/suburban (close to human habitation)	—	—	3·8	2·38	—	—	—	—	2·08
Those which occur in more than one of the above habitats	22·73	50·00	26·92	52·38	56·10	48·15	76·19	52·94	39·74

Table 3. Food preferences of the birds in the 8 vegetation types studied (percentages).

Food preference	Santagal reserve forest	Bidrahalli reserve forest	Sonda reserve forest	Bhairumbe minor forest	Bhairumbe Soppina betta	Sonda teak	Bidrahalli eucalyptus	Muroor/Kallabe betelnut	Uttara Kannada
Marsh feeders	—	—	3·85	—	—	—	—	—	24·16
Predominantly frugivores	45·45	22·73	23·08	23·81	24·39	22·22	14·29	5·88	5·97
Predominantly insectivores	50·00	59·09	61·54	64·29	63·41	62·96	71·43	76·47	40·78
Carnivores	—	—	—	—	—	—	—	—	12·21
Predominantly herbivores	4·55	13·64	7·69	9·52	9·76	11·11	9·52	11·76	7·79
Omnivores	—	—	3·85	2·38	2·44	3·70	4·76	5·88	9·09

Table 4. Countrywide distribution of the species and subspecies of birds recorded in the 8 vegetation types (percentages)

Geographic distribution	Santagal reserve forest	Bidrahalli reserve forest	Sonda reserve forest	Bhairumbe minor forest	Bhairumbe Soppina betta	Sonda teak	Bidrahalli eucalyptus	Muroor/Kallabe betelnut	Uttara Kannada
Birds restricted to western ghats	45·45	31·82	30·77	16·67	9·76	18·52	9·52	17·65	9·87
Birds found in deccan	50·00	63·64	61·54	78·57	92·68	77·78	90·48	82·35	83·9
Birds found in Indus plain	13·64	13·64	15·38	28·57	29·27	33·33	52·38	35·29	54·03
Birds found in Gangetic plain	22·73	50·00	38·46	57·14	60·98	62·96	71·43	64·71	70·39
Birds found in Assam	27·27	31·82	26·92	28·57	39·02	25·93	33·33	29·41	52·99
Birds found in eastern Himalaya	13·64	22·73	19·23	14·29	24·39	37·03	23·81	11·76	29·87
Birds found in western Himalaya	18·18	18·18	19·23	11·90	19·51	14·81	23·81	11·76	27·53
Birds found in Andaman–Nicobar	13·64	18·18	11·54	9·52	14·63	11·11	23·81	5·88	22·59

Santagal being the least disturbed of the 8 localities studied seems to still retain a community of birds more typical of the western ghats than the other man-modified vegetation types On the whole, the gradual shift from the specialist-frugivorous birds, the geographically restricted and those typical of the western ghats to the insectivorous generalists with widespread distribution is probably the result of the displacement of the original forests by secondary forests and plantations Clout and Gaze (1984) report a similar change in the conifer plantations of New Zealand

5. Conclusions

It appears from this study that the tropical rainforests of the western ghats with their wealth of specialist and endemic species and subspecies of birds are slowly giving way to the more generalist and widespread birds as a result of human interference That the better preserved evergreen/semievergreen forests of Uttar Kannada and the later introduced plantations fall far apart in terms of similarity in their bird communities and the typicalness of the birds seen in them can be conceived The plantations however seem to be able to mature/stabilize to support levels of bird species diversity close to that of their vegetation zone The most drastic shift in the bird community from what is typical to the western ghats to the atypical has taken place in the *Eucalyptus* plantation among the 3 plantation types studied This study has also shown that by just looking at species diversity of birds we may not be able to visualize the real change in bird communities due to changes in vegetation Characterizing birds as typical and atypical to any region is a very useful exercise in identifying localities for conservation of birds

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