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Study on pollinators and seed dispersers in scrub, dry evergreen and shola forest ecosystems of Tamil Nadu

**Collaborative Research Project
SACON & Tamil Nadu Forest Department**



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**Salim Ali Centre for Ornithology and Natural History
Coimbatore 641 108**

March 2010

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Final Report (2008-2010)

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Principal Investigator

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Project Staff

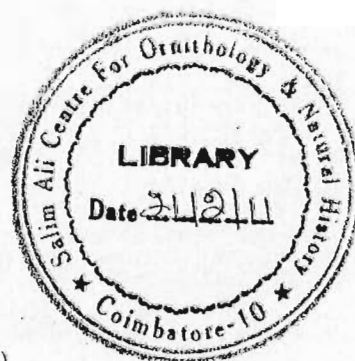
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Introduction

Pollination and seed dispersal are important events in the life of plants. Animal pollinators of flowers and dispersers of seeds are termed as "mutualist". In the mutualistic relationship, the reward to animals is food in the form of nectar or pulp and for the plant it is the benefit of cross pollination or seed dissemination.

The process of pollination and seed dispersal are the fundamentals to the long-term sustainability of plants. The mechanism of pollination among the higher plant groups has been under investigation from very early times and it is highly significant in biological studies. Pollination process comprises of mutual relationship of plants with that of birds, insects, animals and others. The pollinators usually receive pollen and/or nectar from plants in return for their pollinating service. It is through pollination that seed set occurs and on which depends the genetic future of the individual. Birds depend on plants and are benefited by feeding pollen and nectar and the plant species are highly benefited by its pollinators and dispersers as well, which are responsible for reproduction and seed dispersal.

Most of the flowering plants depend on animal vectors for pollen transfer. Effective pollination is a major limitation for the stability of the yield of several economically important plant species (Allen-Wardell, *et al.*, 1998). This is particularly true in the tropics where a larger proportion of species depends on animals as pollinators (Bawa, 1990). Among many other factors, population density of pollinators, their diversity, and visitation frequency, and quantity and quality of the pollen that reaches the stigma are important biotic components affecting pollination success in animal pollination (Kremen *et al.*, 2002, Klein *et al.*, 2003 and Waser and Price, 1991).

Stebbins (1970) proposed that the evolution of pollination systems in animal-pollinated plants has been driven by the foraging behaviour of the main pollinator, regardless of other pollinator visits to a particular plant. This "most effective pollinator principle" implies selection on floral phenotypes that match morphology of the most effective pollinators. Specialized pollination systems are those that attract a limited subset of potential pollinators, often of a particular taxonomic group (e.g., long-tongued hawk moths, bees, hummingbirds, bats), and the flowers reflect the size, morphology, and behavioural traits of the pollinators (Baker, 1961; Faegri and van der Pijl. 1979).

Dispersal provides the opportunity to escape the neighbourhood of the parent plant, and allows seeds to colonize new and potentially more favourable micro sites for seedling establishment (Howe & Smallwood 1982). In bird-dispersed plants, fruit colour is one of the many factors determining fruit choice by birds in the wild (Wheelwright and Janson 1985). Ridely (1936) noted that fruit colours are a form of long distance advertisement to fruit foragers. In fleshy fruited plants, fruit size helps and constrains seed dispersal by animals. In tropical communities, small fruits attract a wider array of dispersal agents than larger ones. Plant species with small fruits are often visited by more species of dispersal agents (Snow 1971, Martin 1985, Howe and Westly 1988 and Dowsett-Lemaire 1988).

Phenology is the study or relationship between climatic factors and periodic phenomena in organisms. Pattern of phonological events are variously used for characterization of vegetation type (Opler et al. 1980; Shimwell 1972). The study of plant phenology provides knowledge about the pattern of plant growth and development as well as the effects of environment and selective pressures on flowering and fruiting behaviour (Zhang et al. 2006).

In India, studies on pollination and seed dispersal in forest ecosystems are not many. Seed dispersal by mammals at Point Calimere was studied by Balasubramanian (1990) and Bole (1993) in the tropical dry evergreen forest of Point Calimere respectively. Avian frugivory and seed dispersal in Coimbatore Forest Division was studied by Balasubramanian et al (1998). Similar studies have also been done in the mixed dry deciduous forests of Anaikatty hills, Western Ghats by Balasubramanian et al (2008) and in the dry deciduous forests, Eastern Ghats (Balasubramanian et al 2009). Ganesh and Davidar (2001) have recorded information on various dispersal modes associated with 82 tree species in a wet evergreen forest of Kakachi in Kalakad-Mundanthurai Tiger Reserve. Though there are many inventories on flora and vegetation diversity in the different forest types of Tamil Nadu, detailed investigations on pollination biology and biotic dispersal of tree species are lacking. Hence, the present study has been initiated.

Objectives

- i. Study the reproductive phenology and find out the flowering, fruiting periods of arborescent flora in the scrub, dry evergreen, and shola forests of Tamil Nadu
- ii. Study the animal visitation to flowers and fruits and find out the pollinators and seed dispersers in the above vegetation types.
- iii. Find out native tree species that attract key pollinators and seed dispersers and suggest them for restoration of degraded forests in Tamil Nadu

Study area

The collaborative research committee suggested to conduct the study on pollinators and seed dispersers in five forest types of Tamil Nadu. Accordingly the following study areas were chosen.

1. Nilgiris – Shola forest
2. Pachamalais – Dry deciduous forest
3. Kanchipuram/Chengalpet/Chennai – Scrub forest
4. Point Calimere – Tropical Dry Evergreen forest
5. Muthupet – Mangrove forest

Methodology

Phenology

To assess the flowering and fruiting season of the plants, phenological studies are very essential. Hence, phenological studies on the fleshy fruit bearing plants and nectar yielding plants were carried out in the study areas. Tagged individuals were observed for phenology in all study areas. Tagged plants were monitored once a month for recording the flowering and fruiting activities. During the observation, percent of flowering and fruiting activity on canopy were noted for each tagged individual as described by Balasubramanian and Bole (1993).

FOREST TYPES STUDIED



Shola Forest



Tropical Dry Evergreen Forest



Dry Deciduous Forest



Scrub Forest



Mangrove Forest

Documentation of insect pollinators

Direct observations were carried out on the inflorescences of select trees, mostly 3 m away from the plant, using a pair of binoculars as well as by using a handheld lens. Extended watches, 6 am to 6 pm were carried out at the focal flowering tree, as described in Santharam (1996) and Pandit and Choudhury (2001). For each tree, 24 hrs observation was made to record the flower visitors. During the observations, the following details were noted: 1) time of the observation 2) name of the flower visitors 3) number of flower visitors 4) time spent by the visitor in each flower 5) whether they collect pollen or feed nectar. The flower visitors are captured by sweeping net and preserved in the insect box.

Documentation of avian pollinators and seed dispersers

Avian frugivores and pollinators were documented by recording the activities of birds foraging on fruit or nectar bearing plants. Extended watches were carried out on focal fruit and nectar producing flowers bearing trees to record the frugivore and pollinator bird visitation. Foraging observation was made following focal animal sampling. The birds were observed between 06:00 am to 06:00 pm by using a pair of binoculars.

Results

Nilgiris: Shola Forest

The Nilgiri hills are located between 10 ° 45 ' - 12 ° 5' N latitude and 76 ° 10' - 77 ° 10' E longitude. Humidity of the area is as high as 80-90% during the southwest monsoon (June-September). The mean temperature of the coldest months is 15 ° C. Mean maximum temperature (26°C) prevails during December. Mean minimum temperature (3°C) prevails during January. The area receives rain from both southwest and northeast monsoon, an average rainfall of the area during 1998-2001 was 2778 mm. The rainfall ranges between 2160 and 3132 mm. Winter and early summer (November-April) are comparatively dry with out notable rainfall.

Methodology

Estimation of food plant abundance/density in the shola forest

Vegetation sampling was done in two shola forests namely, Longwood Shola and Eppanadu Shola. Quantification of flora was carried out using quadrat method since it is the most widely used technique for the plant census. In each of the above site, we laid 10 quadrats of 50x20m size. Totally 20 plots were laid and vegetation quantified in the sites. In each of the quadrat number of individuals of trees and GBH (>20cm) were noted. All the shrubs occurring in the 50x 20 m quadrat was recorded. The data collected was analysed to obtain quantitative structure and composition of plant communities. The density values were calculated for each species following Curtis and McIntosh (1950). The relative value of density, abundance and frequency was determined as per Philips

(1959). From the vegetation data, the abundance and density of food plants of birds were calculated.

Species identification was done by referring the regional floras and counter checked with the Herbaria of the Botanical Survey of India, Southern Circle, Coimbatore.

Density is defined as the number of individuals of a species in a unit area and is an expression of the numerical strength of a species in a community. The density was calculated as follows.

$$\text{Density} = \frac{\text{Total number of individuals}}{\text{Total number of quadrates studied}}$$

Relative density (RD) is the study of numerical strength of a species in relation to total number of all species and is calculated as follows;

$$\text{Relative Density} = \frac{\text{Number of Individuals of a species}}{\text{Number of Individuals of all species}} \times 100$$

Plant diversity in the shola forest of Eppanadu and Longwood

A total of 84 woody species belonging to 45 families were recorded during the vegetation sampling. Of these 54 were tree species and 30 shrub species. Maximum number of individuals was recorded for *Symplocos cochinchinensis* (n=176) followed by *Celtis tetrandra* (n=132) and *Actinodaphne bournei* (n=60) (Table 1). In the Longwood shola forest 874 individuals of trees were found. Among them, maximum values was recorded for *Euonymus crenulatus* (n=93) followed by *Elaeocarpus oblongus* (n=89) and *Celtis tetrandra* (n=78). In the Eppanadu forest area, maximum value for density was observed for *Symplocos cochinchinensis* (17.2) followed by *Celtis tetrandra* (13.2) and *Actinodaphne bournei* (6). In the Longwood shola forest maximum density value recorded for *Euonymus crenulatus* (n=9.3) followed by *Elaeocarpus oblongus* (n=8.9) and *Celtis tetrandra* (n=7.8). (Table.2)

Table 1. Density values of trees in Eppanadu Shola (1 ha.)

S.No	Plant species	No. of individuals	Density	Relative density
1	<i>Acacia mearnsii</i>	2	0.2	0.2
2	<i>Actinodaphne bournei</i>	60	6	5.92
3	<i>Allophylus serratus</i>	24	2.4	2.37
4	<i>Celtis tetrandra</i>	132	13.2	13.03
5	<i>Celtis timorensis</i>	3	0.3	0.3
6	<i>Celtis wightii</i>	6	0.6	0.59
7	<i>Cinnamomum wightii</i>	21	2.1	2.07
8	<i>Cryptocarya lawsonii</i>	23	2.3	2.27
9	<i>Daphniphyllum neilgherrense</i>	36	3.6	3.55
10	<i>Elaeocarpus munroii</i>	15	1.5	1.48
11	<i>Elaeocarpus oblongus</i>	30	3	2.96
12	<i>Eucalyptus globulus</i>	18	1.8	1.78
13	<i>Euonymus crenulatus</i>	8	0.8	0.79
14	<i>Eurya nitida</i>	1	0.1	0.1
15	<i>Euodia lunu-ankenda</i>	2	0.2	0.2
16	<i>Glochidion neilgherrense</i>	7	0.7	0.69
17	<i>Grevillea robusta</i>	6	0.6	0.59
18	<i>Hydnocarpus alpina</i>	17	1.7	1.68
19	<i>Isonandra perrottetii</i>	12	1.2	1.18
20	<i>Ixora notoniana</i>	21	2.1	2.07
21	<i>Ligustrum perrottetii</i>	12	1.2	1.18
22	<i>Litsea wightiana</i>	19	1.9	1.88
23	<i>Maesa indica</i>	11	1.1	1.09
24	<i>Mahonia leschenaultii</i>	6	0.6	0.59
25	<i>Meliosma wightii</i>	23	2.3	2.27
26	<i>Memecylon malabaricum</i>	5	0.5	0.49
27	<i>Michelia nilagirica</i>	10	1	0.99
28	<i>Rapanea wightiana</i>	8	0.8	0.79
29	<i>Neolitsea scrobiculata</i>	29	2.9	2.86
30	<i>Nothapodytes nimmoniana</i>	28	2.8	2.76
31	<i>Olea glandulifera</i>	5	0.5	0.49
32	<i>Phoebe lanceolata</i>	19	1.9	1.88
33	<i>Rhamnus virgatus</i>	11	1.1	1.09

34	<i>Rhododendron nilagiricum</i>	4	0.4	0.39
35	<i>Schefflera racemosa</i>	17	1.7	1.68
36	<i>Symplocos cochinchinensis</i>	176	17.6	17.37
37	<i>Symplocos foliosa</i>	29	2.9	2.86
38	<i>Syzygium densiflorum</i>	56	5.6	5.53
39	<i>Syzygium cumini</i>	12	1.2	1.18
40	<i>Syzygium tamilnadensis</i>	8	0.8	0.79
41	<i>Ternstroemia japonica</i>	3	0.3	0.3
42	<i>Toona celiata</i>	3	0.3	0.3
43	<i>Turpinia nepalensis</i>	12	1.2	1.18
44	<i>Vaccinium leschenaultii</i>	8	0.8	0.79
45	<i>Vaccinium neilgherrense</i>	44	4.4	4.34
46	<i>Vernonia monosis</i>	11	1.1	1.09

Table 2. Density values of trees in Longwood Shola (1 ha.)

S.No	Plant Name	#	Density	Relative density
1	<i>Actinodaphne bournei</i>	25	2.5	2.86
2	<i>Albizia lophantha</i>	4	0.4	0.46
3	<i>Celtis tetrandra</i>	78	7.8	8.92
4	<i>Celtis wightii</i>	5	0.5	0.57
5	<i>Cinnamomum wightii</i>	1	0.1	0.11
6	<i>Cryptocarya lawsonii</i>	8	0.8	0.92
7	<i>Daphniphyllum neilgherrense</i>	16	1.6	1.83
8	<i>Dillenia pentagyna</i>	1	0.1	0.11
9	<i>Elaeocarpus munroii</i>	4	0.4	0.46
10	<i>Elaeocarpus oblongus</i>	89	8.9	10.18
11	<i>Euonymus crenulatus</i>	93	9.3	10.64
12	<i>Eurya nitida</i>	18	1.8	2.06
13	<i>Euodia lunu-ankenda</i>	51	5.1	5.84
14	<i>Glochidion neilgherrense</i>	35	3.5	4
15	<i>Hydnocarpus alpina</i>	11	1.1	1.26
16	<i>Ilex wightiana</i>	10	1	1.14

17	<i>Isonandra perrottetiana</i>	34	3.4	3.89
18	<i>Ixora notoniana</i>	32	3.2	3.66
19	<i>Ligustrum perrottetii</i>	14	1.4	1.6
20	<i>Litsea wightiana</i>	1	0.1	0.11
21	<i>Maesa indica</i>	1	0.1	0.11
22	<i>Mahonia leschenaultii</i>	11	1.1	1.26
23	<i>Memecylon malabaricum</i>	15	1.5	1.72
24	<i>Michelia champaca</i>	1	0.1	0.11
25	<i>Michelia nilagirica</i>	6	0.6	0.69
26	<i>Microtropis densiflora</i>	7	0.7	0.8
27	<i>Rapanea wightiana</i>	24	2.4	2.75
28	<i>Neolitsea scrobiculata</i>	25	2.5	2.86
29	<i>Neolitsea cassia</i>	9	0.9	1.03
30	<i>Nothapodytes nimmoniana</i>	20	2	2.29
31	<i>Phoebe lanceolata</i>	31	3.1	3.55
32	<i>Pittosporum nilghirens</i>	15	1.5	1.72
33	<i>Prunus ceylanica</i>	1	0.1	0.11
34	<i>Rhododendron nilagiricum</i>	2	0.2	0.23
35	<i>Schefflera racemosa</i>	5	0.5	0.57
36	<i>Symplocos cochinchinensis</i>	24	2.4	2.75
37	<i>Symplocos foliosa</i>	8	0.8	0.92
38	<i>Syzygium densiflorum</i>	14	1.4	1.6
39	<i>Syzygium cumini</i>	22	2.2	2.52
40	<i>Syzygium tamilnadensis</i>	16	1.6	1.83
41	<i>Turpinia nepalensis</i>	11	1.1	1.26
42	<i>Vaccinium leschenaultii</i>	15	1.5	1.72
43	<i>Vaccinium neilgherrense</i>	9	0.9	1.03
44	<i>Vernonia monosis</i>	40	4	4.58
45	<i>Viburnum punctatum</i>	12	1.2	1.37

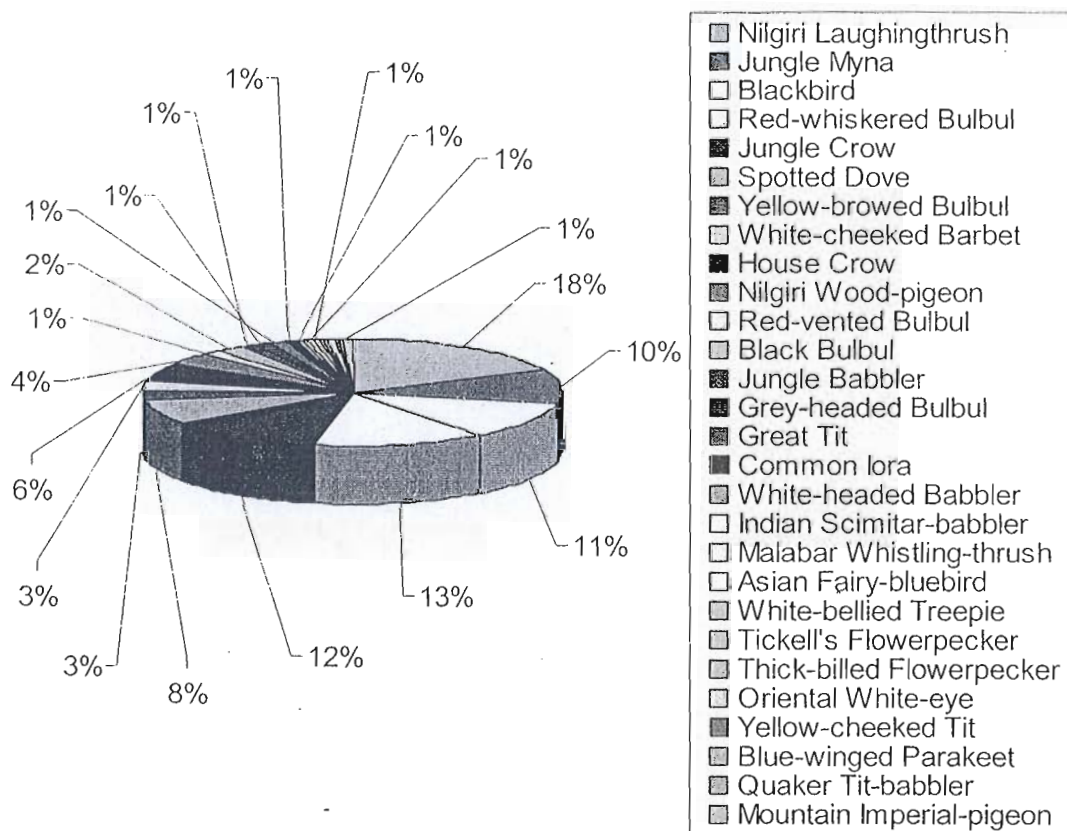
Table 3. Phenology profile of trees in the shola forests of Nilgiris (Dec. 2008-Mar. 2010)

		Dec		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Jan		Feb		Mar	
	Plant species	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr
1	<i>Celtis tetrandra</i>	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+
2	<i>Daphniphyllum nelgherrense</i>	+	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+
3	<i>Elaeocarpus oblongus</i>	-	-	+	-	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+
4	<i>Euonymus crenulatus</i>	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	
5	<i>Eurya nitida</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	<i>Evodia linu-ankenda</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	<i>Glochidion nelgherrense</i>	+	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+
8	<i>Isonandra candolleana</i>	+	-	+	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+
9	<i>Ixora notoniana</i>	+	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+
10	<i>Ligustrum perrottetii</i>	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+
11	<i>Memecylon malabaricum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	<i>Michelia champaca</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	<i>Microtropis densiflora</i>	+	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+
14	<i>Myrsine wightiana</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	<i>Neolitsea scrobiculata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	<i>Nothapodytes nimmoniana</i>	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+
17	<i>Phoebe lanceolata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	<i>Rhododendron arboreum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	<i>Symplocos cochinchinensis</i>	+	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+
20	<i>Syzygium densiflorum</i>	-	-	-	-	-	-	-	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-	+	-
21	<i>Syzygium taminadensis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	<i>Turpinia nepalensis</i>	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	<i>Vernonia monensis</i>	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Fruit eating birds observed in the Shola forests of Nilgiris

A total of 23 fleshy fruited tree species was observed to record the fruit eating birds in the shola forests of Nilgiris. A total of 6543 individuals belonging to 28 frugivorous bird species were recorded. Most frequent frugivorous visitors observed include Nilgiri Laughingthrush (18.02%) followed by Red-whiskered Bulbul (13.30%) and Jungle Crow (12.03%). Nilgiri Laughingthrush and Redwhikered Bulbul appear to be major seed dispersers in the Shola forest. Nilgiri Laughing thrush and Red-whiskered Bulbul visited 18 plant species. Most of the avian frugivores were attracted by *Ilex wightiana* (n=17) followed by *Daphniphyllum neilgherrense* (n=9) and *Syzygium montanum* (n=9) (Fig. 1).

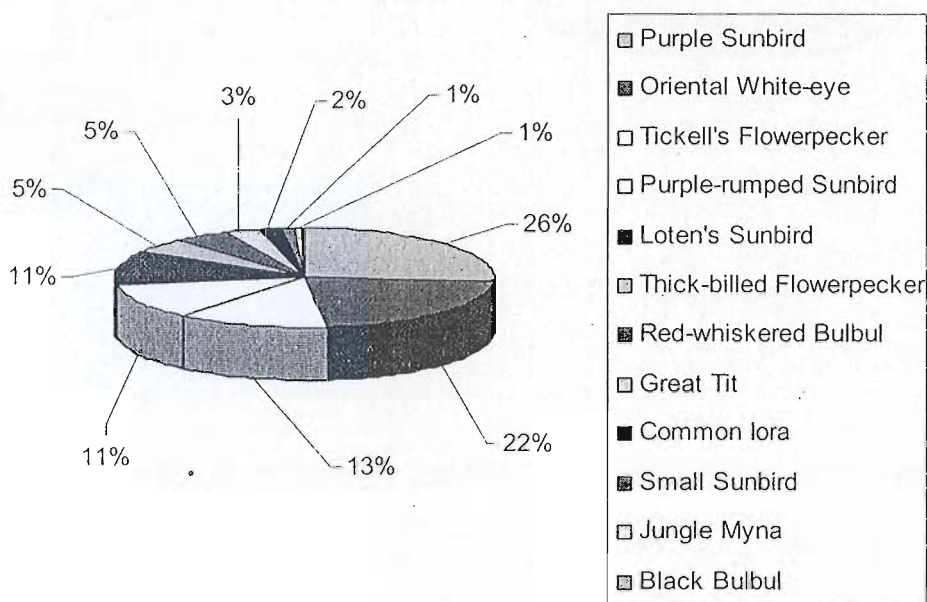
Fig. 1. Frugivore visits to fleshy fruited plants in Shola forests of Nilgiris



Nectar feeding birds recoded in Longwood and Eppanadu Shola

A total of seven tree species were observed for recording the nectar feeding birds. A total of 2144 individuals belonging to 10 species of nectarivorous birds were recorded. Maximum number of nectarivorous species were attracted by *Isonandra candolleana* (n=8) followed by *Euodia lumu-ankenda* (n=7) and *Phoebe lanceolata* (n=6). Maximum number of individuals of nectarivores were recorded in *Isonandra perrottetiana* (n=650). Among the nectarivores, Purple sunbird (26.31%) followed by Oriental White-eye (21.74%) and Tickell's Flowerpecker (13.11%) made frequent visits. These species appear to be the major nectarivores in the shola forest (Fig. 2).

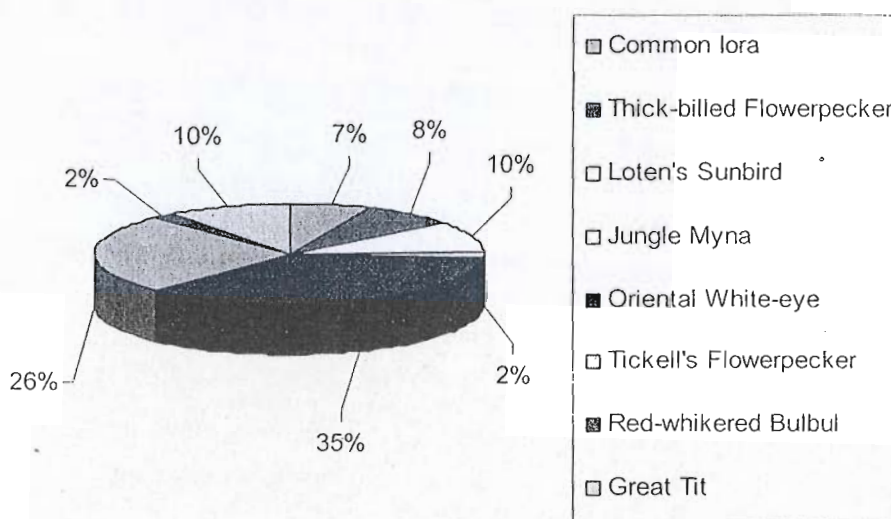
Fig. 2 Nectar feeding birds visits in two Shola forests of Nilgiris



Isonandra perrottetiana

A total of 650 individuals belonging to eight species of nectarivorous birds were recorded. Among them maximum number of individuals were represented by Oriental White-eye (35.69%) followed by Tickell's Flowerpecker (25.85%) and Loten's Sunbird (10.15%) (Fig. 3).

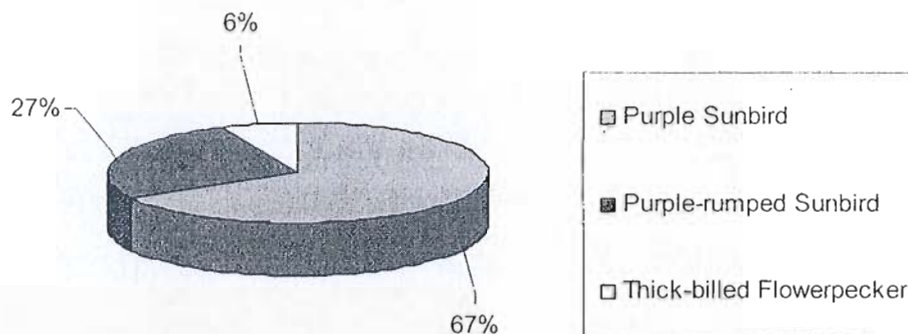
Fig. 3 Nectarivorous bird visits to *Isonandra perrottetiana*



Syzygium tamilnadensis

A total of 269 individuals of three species nectarivorous bird species were recorded. Maximum number of nectarivorous birds observed include Purple sunbird (66.91%) followed by Purple-rumped Sunbird (26.77%) and Thick-billed flowerpecker (6.32%) (Fig.4).

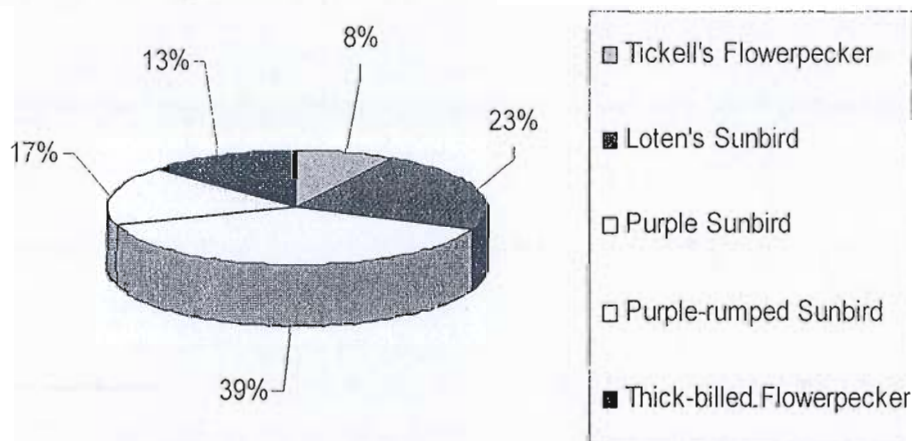
Fig. 4 Nectarivorous bird visits to *Syzygium tamilnadensis*



Syzygium cumini

A total of 312 individuals of 5 species nectarivorous birds were recorded. Maximum number of nectarivorous birds observed include Purple sunbird (38.46%) followed by Loten's Sunbird (23.08%) and Purple-rumped Sunbird (16.99%) (Fig. 5).

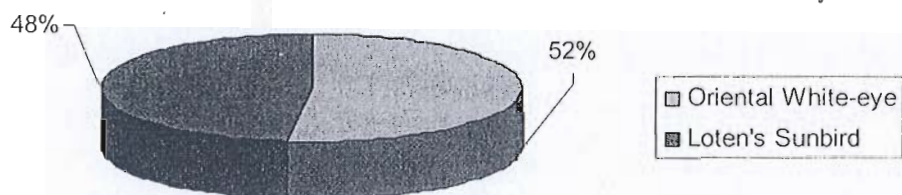
Fig. 5 Nectarivorous bird visits to *Syzygium cumini*



Symplocos cochinchinensis

Total of 123 individuals belonging to two species were recorded on *Symplocos cochinchinensis* in the Shola forest of Nilgiris. Maximum number of nectarivorous birds observed include Oriental White-eye (52.03%) followed by Loten's Sunbird (47.97%) (Fig.6).

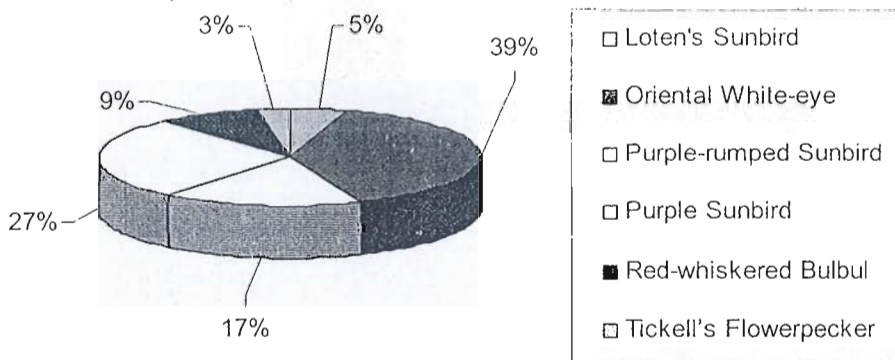
Fig. 6 Nectarivorous bird visits to *Symplocos cochinchinensis*



Phoebe lanceolata

A total of 278 individuals belonging to 6 species of nectari vorous birds were recorded. Maximum number of individuals represented by Oriental White-eye (38.85%) followed by Purple Sunbird (27.34%) and Red-whiskered Bulbul (17.27%) (Fig. 7).

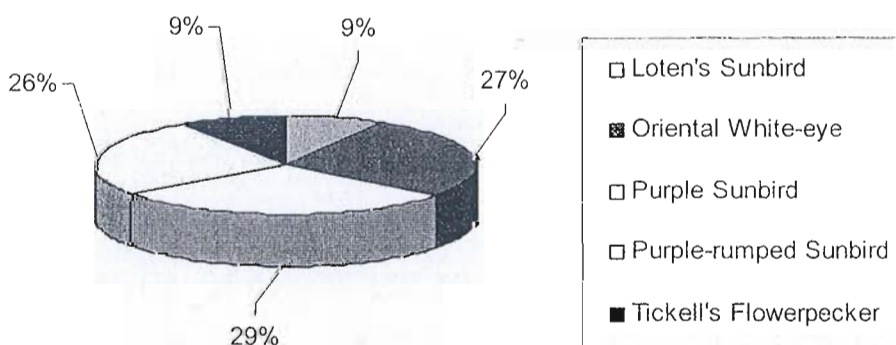
Fig.7 Nectarivorous bird visits to *Phoebe lanceolata*



Ixora notoniana

A total of 231 individuals belonging to 5 species of nectarivores were recorded. Maximum number of nectarivorous bird species observed include Purple Sunbird (29.44%) followed by Oriental White-eye (26.84%) and Purple-rumped Sunbird (25.97%) (Fig. 8).

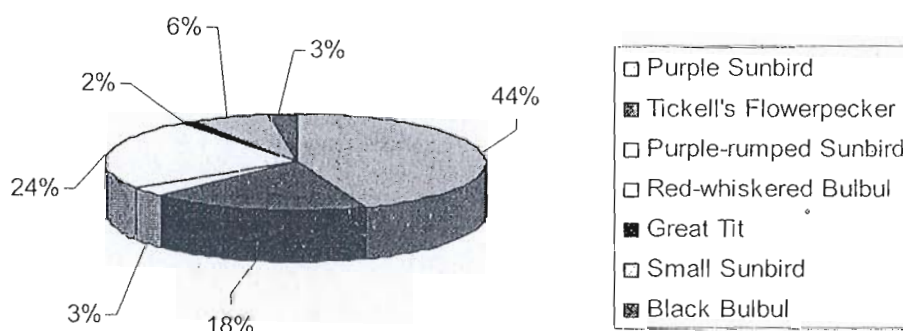
Fig. 8 Nectarivorous bird visits to *Ixora notoniana*



Euodia lunu-ankenda

A total of 317 individuals belonging to 7 species of nectarivores were recorded. Majority of nectarivores represented by Purple Sunbird (44.16%) followed by Red-whiskered Bulbul (23.66%) and Tickell's Flowerpecker (18.30%) (Fig. 9).

Fig. 9 Nectarivorous bird visits to *Euodia lunu-ankenda*

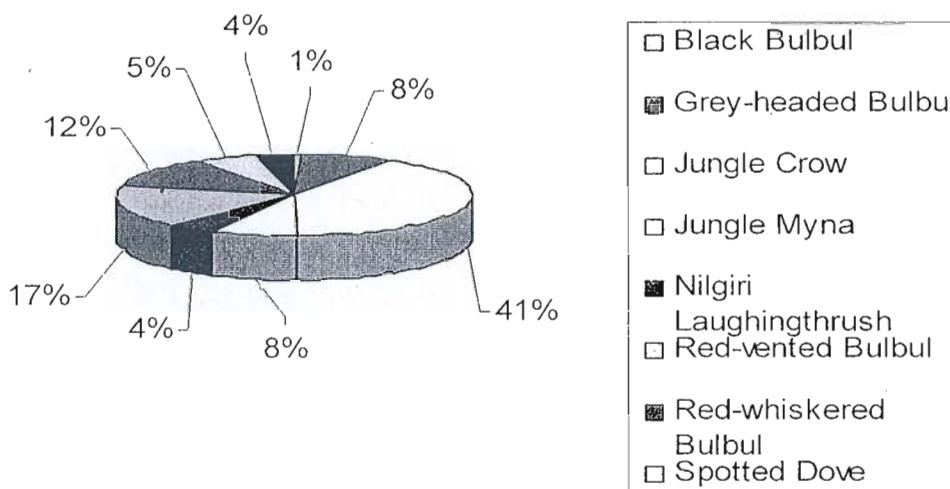


Frugivorous birds in the Shola forests

Daphniphyllum neilgherrense

A total of 490 individuals belonging to 9 species of frugivorous birds were recorded. Majority of frugivores observed include Jungle Crow (40.82%) followed by Red-vented Bulbul (17.14%) and Red-whiskered Bulbul (12.04%) (Fig. 10).

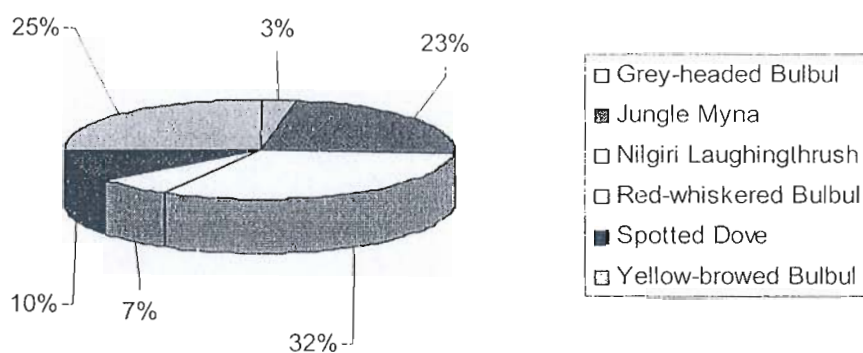
Fig.10 Frugivorous bird visits to *Daphniphyllum neilgherrense*



Ligustrum perrottetii

A total of 319 individuals belonging to 6 species of frugivorous birds were recorded. Majority of frugivores recorded include Nilgiri Laughingthrush (31.97%) followed by Yellow-browed Bulbul (25.39%) and Jungle Myna (22.88%) (Fig. 11).

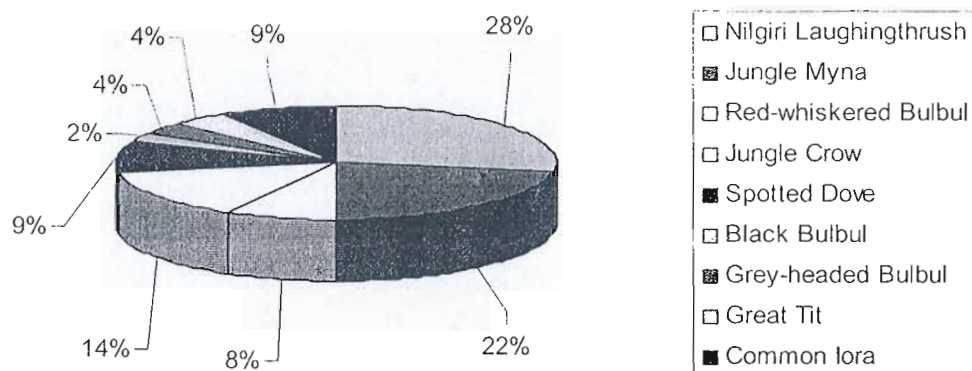
Fig. 11. Frugivorous bird visits to *Ligustrum perrottetii*



Isonandra perrottetiana

A total of 400 individuals belonging to 9 species of frugivorous birds were recorded. Majority of frugivores recorded include Nilgiri Laughingthrush (27.25%) followed by Jungle Myna (22.25%) and Common Iora (8.75%) (Fig. 12).

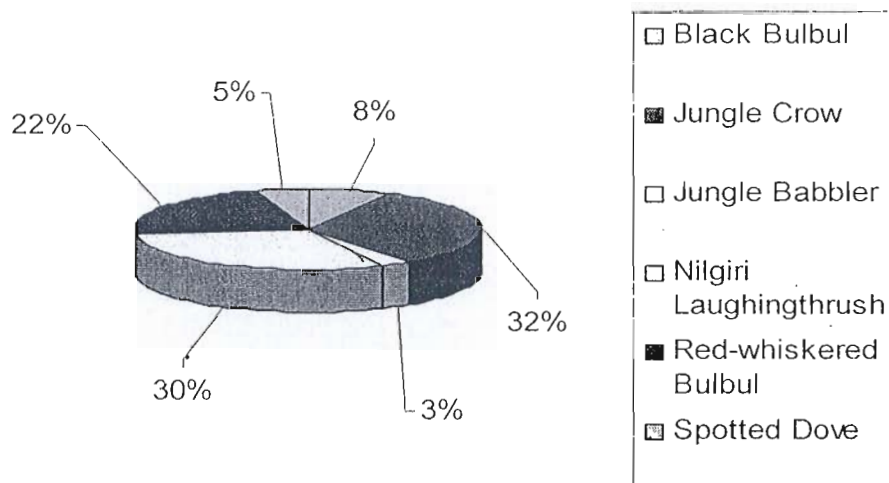
Fig. 12 Frugivorous bird visits to *Isonandra perrottetiana*



Microtropis densiflora

A total of 420 individuals belonging to 6 species of frugivorous birds were recorded. Majority of frugivores observed include Jungle Crow (32.14%) followed by Nilgiri Laughingthrush (30.48%) and Red-whiskered Bulbul (21.90%) (Fig. 13).

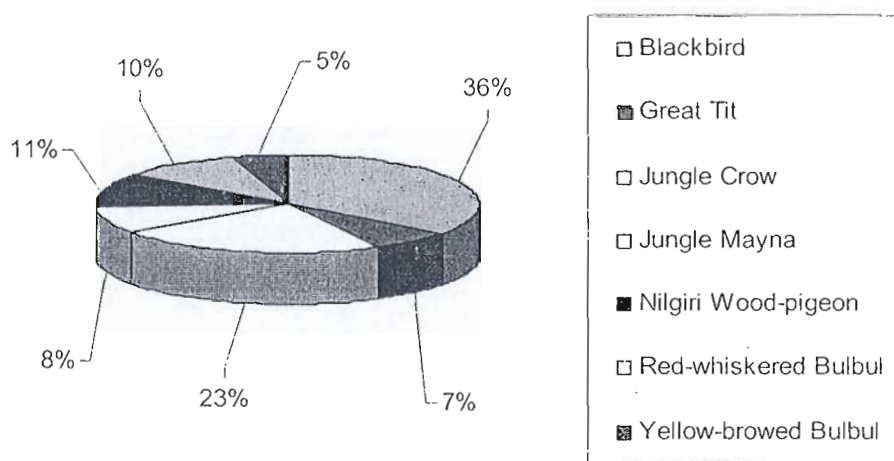
Fig. 13 Frugivorous bird visits to *Microtropis densiflora*



Zizyphus xylopyrus

A total of 274 individuals belonging to 7 species of frugivorous birds were recorded. Majority of frugivores observed include Black Bird (35.40%) followed by Jungle Crow (22.99%) and Nilgiri Wood-Pigeon (11.31%) (Fig. 14).

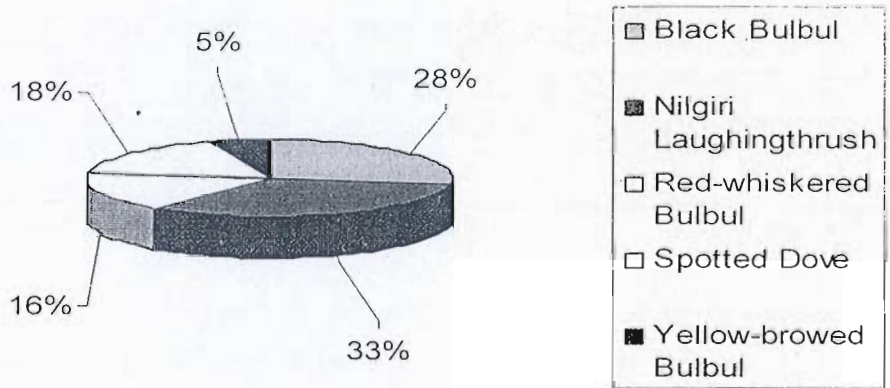
Fig. 14 Frugivorous bird visits to *Zizyphus xylopyrus*



Symplocos cochinchinensis

A total of 310 individuals belonging to 5 species of frugivorous birds were recorded. Most frequently visited frugivores include Nilgiri Laughing thrush (33.23%) followed by Black Bulbul (27.74%) and Spotted Dove (17.74%) (Fig. 15).

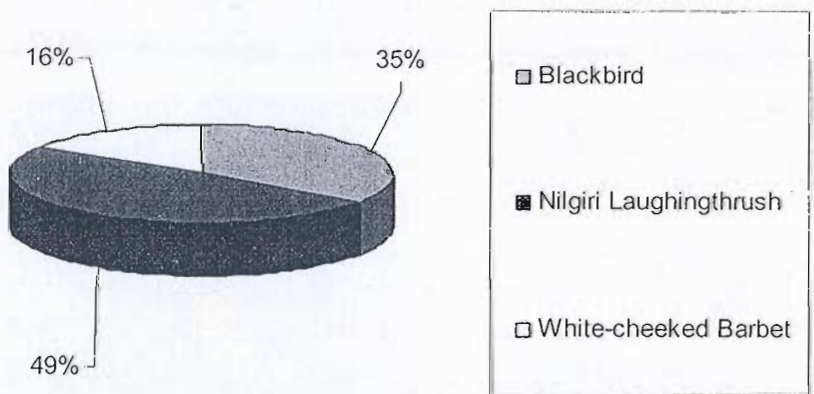
Fig.15 Frugivorous bird visits to *Symplocos cochinchinensis*



Glochidion neilgherrense

A total of 336 individuals belonging to 3 species of frugivorous birds were recorded. Majority of frugivores observed include Nilgiri Laughingthrush (49.40%) followed by Black Bird (34.52%) and White-cheeked Barbet (16.07%) (Fig. 16).

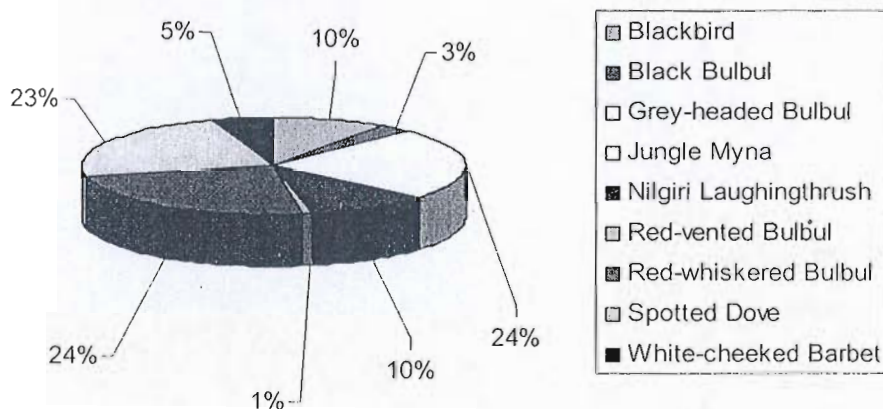
Fig. 16 Frugivorous bird visits to *Glochidion neilgherrense*



Syzygium tamilnadensis

A total of 680 individuals belonging to 9 species of frugivorous birds were recorded. Maximum number of frugivores recorded include Red-whiskered Bulbul (24.26%) followed by Jungle Myna (23.82%) and Spotted Dove (22.94%) (Fig. 17).

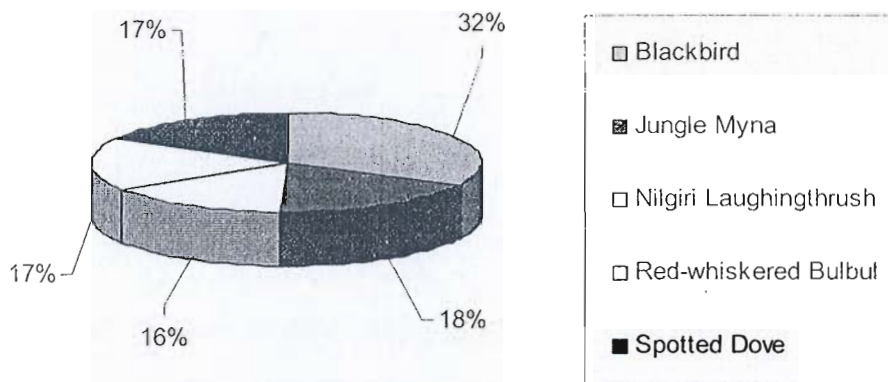
Fig. 17 Frugivorous bird visits to *Syzygium tamilnadensis*



Syzygium cumini

A total of 200 individuals belonging to 5 species of frugivores were recorded. Maximum number of frugivorous observed include Black Bird (32.50%) followed by Jungle Myna (18%) Red-whiskered Bulbul (17%) and Spotted Dove (17%) (Fig. 18).

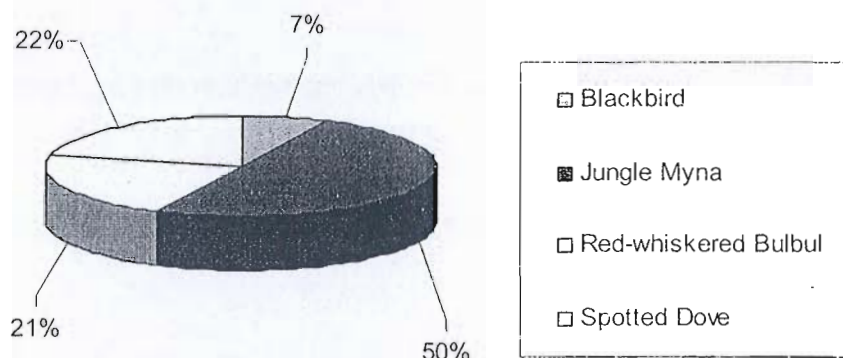
Fig. 18 Frugivorous bird visits to *Syzygium cumini*



Syzygium densiflorum

A total of 179 individuals belonging to 4 species of frugivorous were recorded. Majority of frugivores recorded include Jungle Myna (49.72%) followed by Spotted Dove (21.79%) and Red-whiskered Bulbul (21.23%) (Fig. 19).

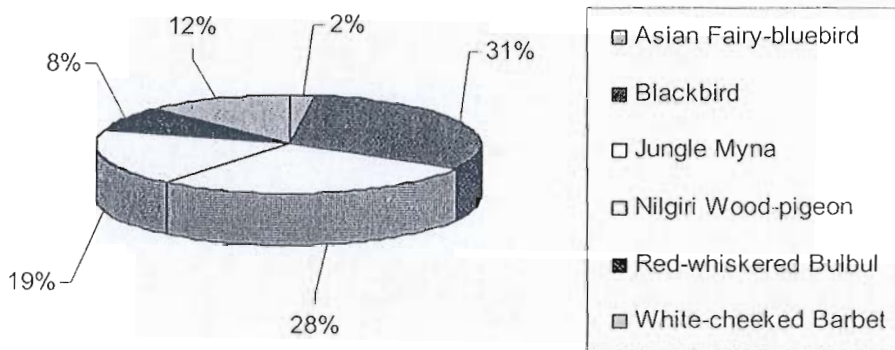
Fig. 19 Frugivorous bird visits to *Syzygium densiflorum*



Celtis tetrandra

A total of 350 individuals belonging to 6 species of frugivores were recorded. Maximum number of frugivorous observed include Black bird (30.86%) followed by Jungle Myna (n=21.71) and Nilgiri Wood-Pigeon (18.86%) (Fig. 20).

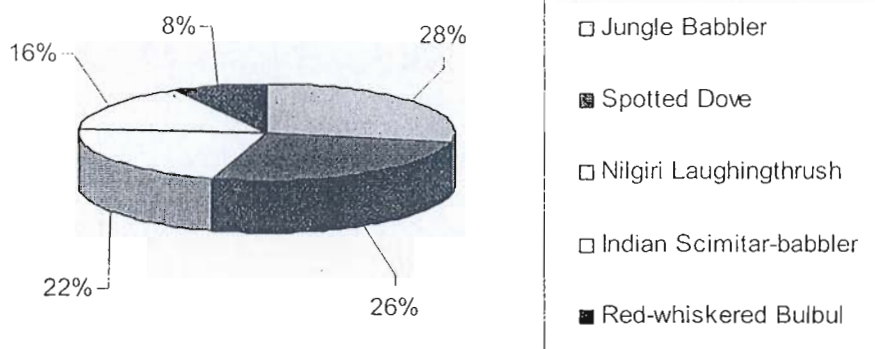
Fig. 20. Frugivorous bird visits to *Celtis tetrandra*



Turpinia nepalensis

A total of 174 individuals belonging to 5 species of frugivorous were recorded. Maximum number of frugivores recorded include Jungle Babbler (28.16%) followed by Spotter Dove (26.44%) and Nilgiri Laughingthrush (21.84%) (Fig. 21).

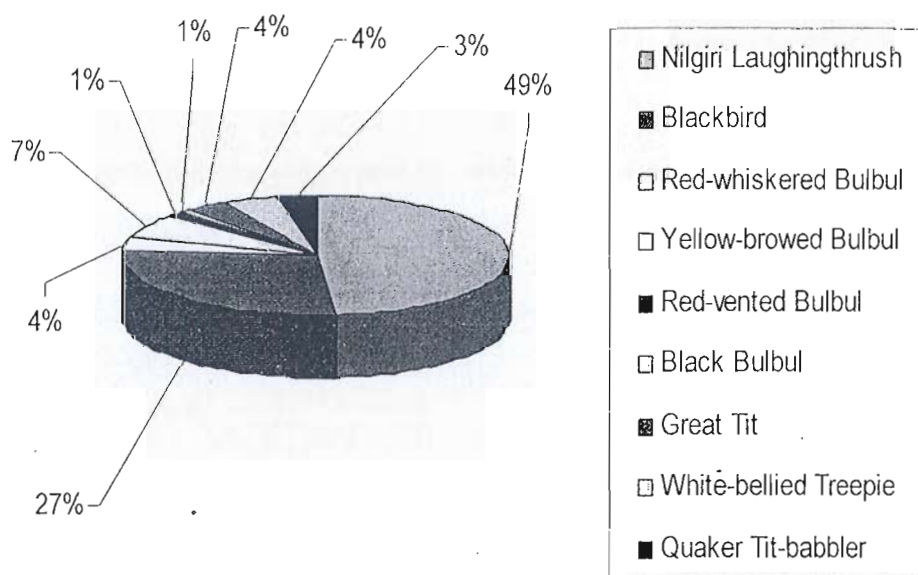
Fig. 21 Frugivorous bird visits to *Turpinia nepalensis*



Ixora notoniana

Totally 182 individuals belonging to 9 species of frugivorous birds were recorded. Maximum number of individuals observed included Nilgiri Laughing Thrush (48.35%) followed by Black Bird (27.47%) and Yellow-browed Bulbul (6.59%) (Fig. 22).

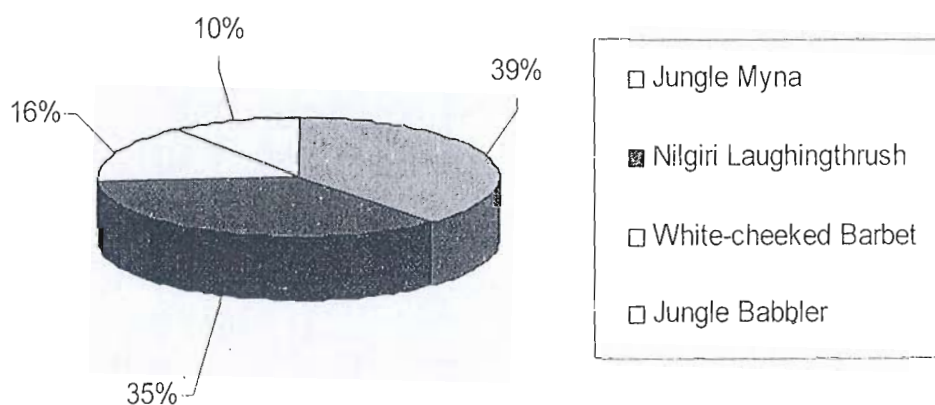
Fig. 22 Frugivorous bird visits to *Ixora notoniana*



Litsea wightiana

A total of 96 individuals belonging to 4 species of frugivorous were recorded. Maximum number of frugivores recorded include Jungle Myna (38.54%), followed by Nilgiri Laughingthrush (35.42%) and White-cheeked Barbet (15.63%) (Fig. 23).

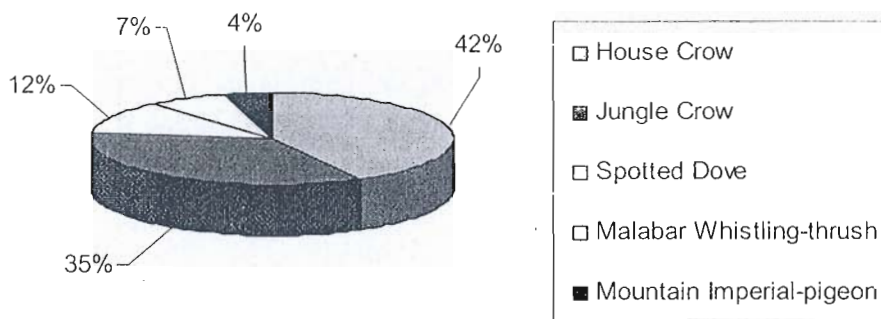
Fig. 23 Frugivorous bird visits to *Litsea wightiana*



Elaeocarpus oblongus

A total of 333 individuals belonging to 5 species of frugivores were recorded. Maximum number of frugivorous bird species observed include House Crow (42.04%) followed by Jungle Crow (34.53%) and Spotted Dove (12.01%) (Fig. 24).

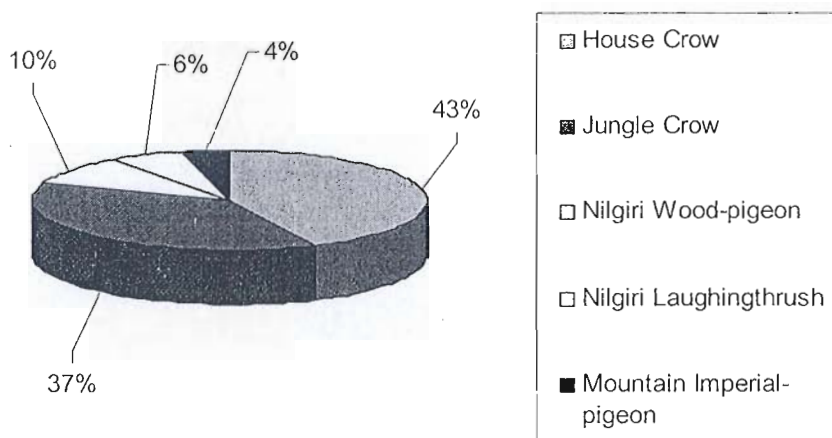
Fig. 24 Frugivorous bird visits to *Elaeocarpus oblongus*



Elaeocarpus munroii

A total of 262 individuals belonging to 5 species of frugivores were recorded. Majority of frugivorous bird species observed include House Crow (42.75%) followed by Jungle Crow (37.40%) and Nilgiri Wood-pigeon (9.92%) (Fig. 25).

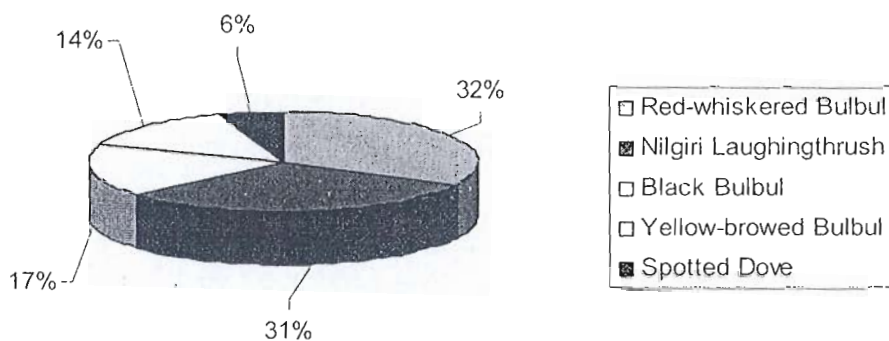
Fig. 25 Frugivorous bird visits to *Elaeocarpus munroii*



Michelia champaca

A total of 71 individuals belonging to 5 species of frugivores were recorded. Majority of frugivorous bird species observed include Red-whiskered Bulbul (32.39%) followed by Nilgiri Laughingthrush (30.99%) and Black Bulbul (16.90%) (Fig. 26).

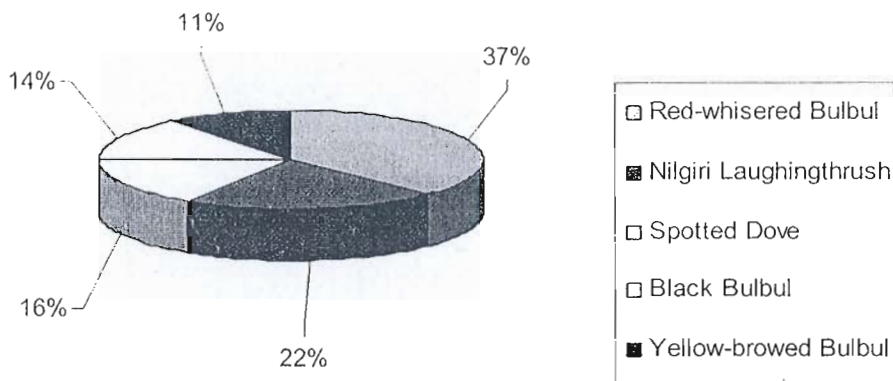
Fig. 26 Frugivorous bird visits to *Michelia champaca*



Michelia nilagirica

A total of 93 individuals belonging to 5 species of frugivores were recorded. Majority of frugivorous bird species observed include Red-whiskered Bulbul (37.63%) followed by Nilgiri Laughingthrush (21.51%) and Spotted Dove (16.13%) (Fig. 27).

Fig. 27 Frugivorous bird visits to *Michelia nilagirica*

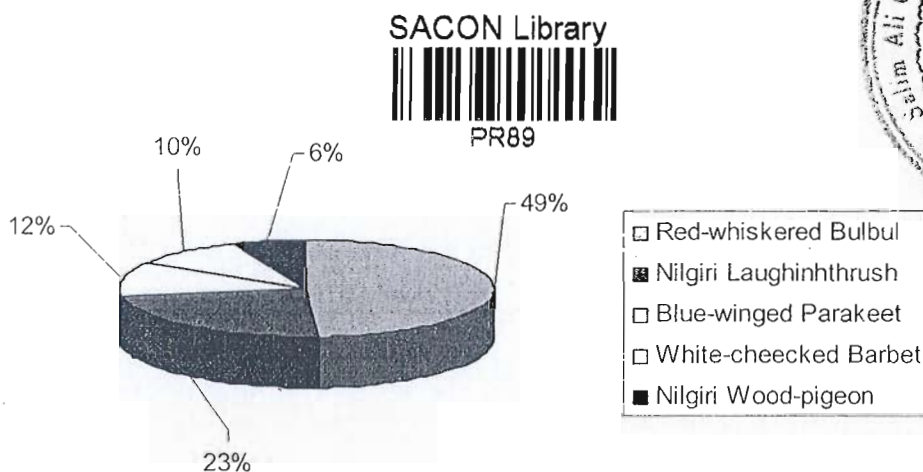


Memecylon malabaricum

A total of 237 individuals belonging to 5 species of frugivores were recorded. Maximum number of frugivorous bird species observed include Red-whiskered Bulbul (48.95%) followed by Nilgiri Laughingthrush (23.21%) and Blue-winged Parakeet (11.81%) (Fig. 28).

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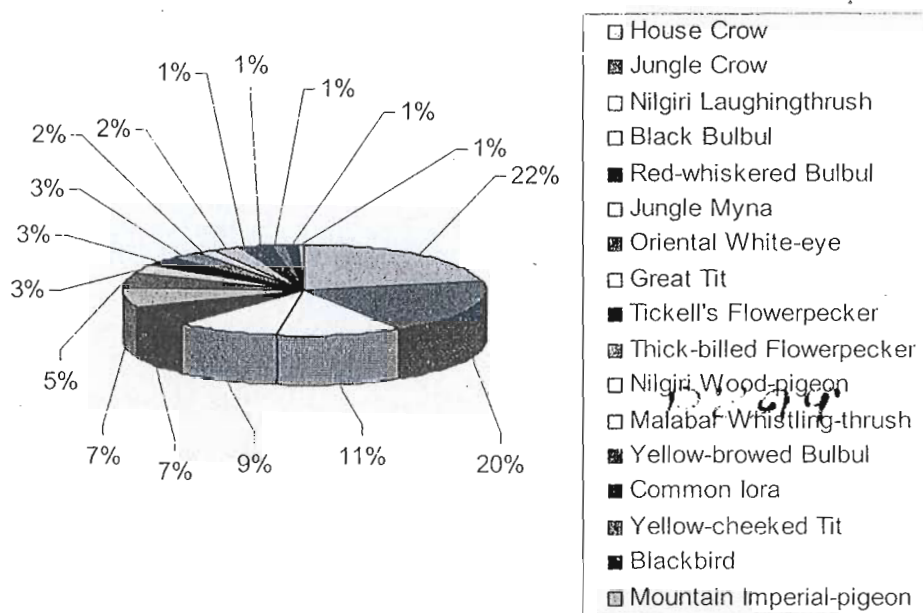
Fig. 28 Frugivorous bird visits to *Memecylon malabaricum*



Ilex wightiana

A total of 603 individuals belonging to 17 species of frugivores were recorded. Maximum number of frugivorous bird species observed include House Crow (21.56%) followed by Jungle Crow (19.73%) and Nilgiri Laughingthrush (11.28%) (Fig. 29).

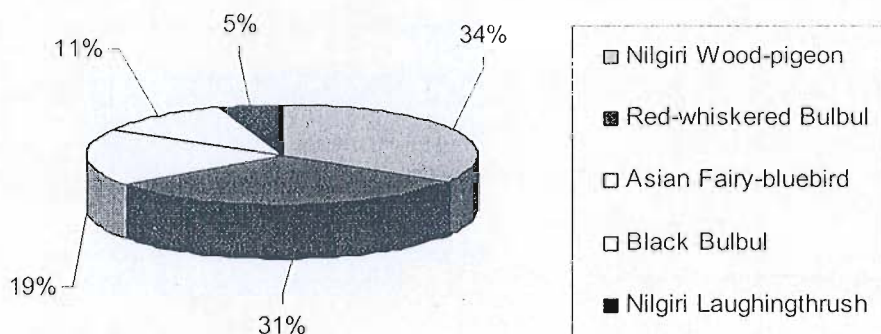
Fig. 29 Frugivorous bird visits to *Ilex wightiana*



Symplocos foliosa

A total of 150 visits was made by 5 species of frugivorous birds. Most frequently visited frugivores included Nilgiri Wood-pigeon (34%) followed by Red-whiskered Bulbul (30.67%) and Asian Fairy-bluebird (18.67%) (Fig. 30).

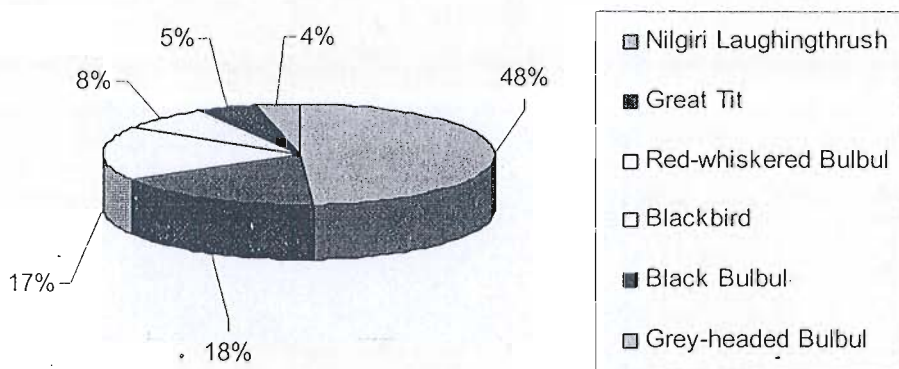
Fig 30 Frugivorous bird visits to *Symplocos foliosa*



Eurya nitida

A total of 200 individuals belonging to 6 species of frugivores were recorded. Maximum number of frugivorous bird species observed include Nilgiri Laughingthrush (49.00) followed by Great Tit (17.50) and Red-whiskered Bulbul (17.00) (Fig. 31).

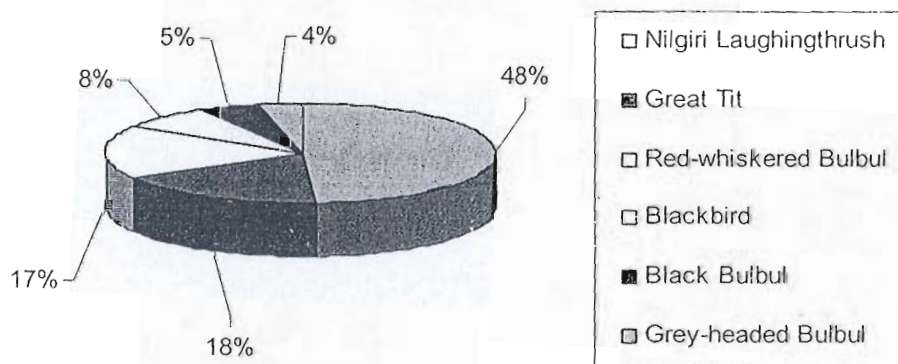
Fig 31 Frugivorous bird visits to *Eurya nitida*



Nothapodytes nimmoniana

A total of 184 individuals belonging to 6 species of frugivores were recorded. Maximum number of frugivorous bird species observed include Blackbird (40.22%) followed by Red-whiskered Bulbul (21.20%) and Nilgiri Wood-pigeon (19.02%) (Fig. 32).

Fig. 32 Avian frugivore visits to *Nothapodytes nimmoniana*



Insect pollinators in the shola forests of Nilgiris

A total of 3868 individuals belonging to 6 groups of insects were recorded in the Shola forests of Nilgiris. Majority of the insect visitors to flowers include honey bee (35.50%) followed by butterfly (25.16%) and other flies (24.10%) (Table 4).

Table 4 Insect pollinator visits to different plant species in the shola forests

S.No	Insect Name	N.S	I.C	S.C	Sy.Ch	S.M	G.N	I.N	E.D	P.L	E-A	No of visits	%
1	Butterflies	87	100	100	109	214	110	22	82	-	149	973	25.16
2	Honey Bee	133	80	179	232	187	98	112	131	120	101	1373	35.50
3	Beetles	12	-	-	-	-	-	-	-	-	-	12	0.31
4	Other Bees	13	41	55	117	92	66	-	-	-	-	384	9.93
5	Wasps	-	42	-	58	39	-	-	-	55	-	194	5.02
6	Flies	207	-	188	67	208	-	28	98	42	94	932	24.10
	Total	452	263	522	583	740	274	162	311	217	344	3868	100.00

N.S = *Neolitsea scrobiculata*, I.C = *Isonandra candolleana*, S.C = *Syzygium cumini*,
G.N= *Glochidion neilgherrense*, I.N=*Ixora notoniana*, E.D=*Euonymus dichotomous*,

Sy. Ch = *Symplocos cochinchinensis*, S.M = *Syzygium montanum*,
P.L=*Phoebe lanceolata*, E-A=*Euodia lunu-ankenda*.

Among the various insects, honey bees made maximum number visits. Honey bees visited all the observed plant species. They seem to be the major pollinators in shola forests.

Butterfly visitors to different plant species in shola forests

A total of 1374 individuals belonging to 9 butterfly species on the 11 plant species were observed in the shola forests of Nilgiris. Maximum number of butterflies were observed on *Ligustrum perrottetii* (n=219) followed by *Syzygium montanum* (214) and *Daphniphyllum neilgherrense* (n=182) (Table 5).

Table 5. Butterfly visitors to different plant species in shola forests

S.No	Name of Plants	C.S	S.S	B.A	B.B	I.C.W	B.T	Y.H	C.R	C.G.Y	No of visits	%
1	<i>Neolitsea scrobiculata</i>	21	19	24	-	23	-	-	-	-	87	6.33
2	<i>Isonandra candolleana</i>	-	-	-	45	-	25	30	-	-	100	7.28
3	<i>Syzygium scumini</i>	-	-	-	-	-	-	76	24	-	100	7.28
4	<i>Symplocos cochinchinensis</i>	-	30	16	33	12	18	-	-	-	109	7.93
5	<i>Syzygium montanum</i>	-	68	-	97	-	49	-	-	-	214	15.57
6	<i>Glochidion neilgherrensis</i>	25	18	-	-	21	-	46	-	-	110	8.01
7	<i>Ixora notoniana</i>	-	-	-	-	-	-	-	-	22	22	1.60
8	<i>Euonymus dichotomous</i>	-	-	-	-	-	-	82	-	-	82	5.97
9	<i>Euodia lunt-ankenda</i>	-	-	-	94	-	-	55	-	-	149	10.84
10	<i>Ligustrum perrottetii</i>	-	-	-	75	-	32	112	-	-	219	15.94
11	<i>Daphniphyllum neilgherrense</i>	-	-	-	67	-	-	115	-	-	182	13.25
	Total	46	135	40	411	56	124	516	24	22	1374	100.00

C.S= Common Sailor, S.S= Silver Strip, B.B = Common Blue Bottle, I.C.W = Indian Cabbage White, B.T = Blue Tiger, Y.H = Yellow Helen, C.R = Crimson Rose, C.G.Y=Common Grass Yellow, B.A=Blue Admiral

Insect pollinators to different plant species in the shola forests

Neolitsea scrobiculata

A total of 452 individuals belonging to 5 insect groups were recorded in the plant of *Neolitsea scrobiculata*. The most frequent flower visitors were, flies (n=207), followed by honey bees (n=133), butterflies (n=87) and carpenter bees (n=13) (Table 6).

Table 6. Insect pollinators of *Neolitsea scrobiculata*

S.No	Name of Insect	No of visits	%
1	Butterflies	87	19.25
2	Flies	207	45.80
3	Carpenter Bees	13	2.88
4	Honey Bees	133	29.42
5	Beetles	12	2.65
	Total	452	100.00

Isonandra perrottetiana

A total of 263 individuals belonging to 4 groups were recorded in the plant of *Isonandra candolleana*. The most frequent flower visitors were, butterflies (n=100), followed by, honey bees (n=80) and carpenter bees (n=41) (Table7).

Table 7. Insect pollinators of *Isonandra candolleana*

S.No	Name of Insect groups	No of visits	%
1	Butterflies	100	38.02
2	Carpenter Bees	41	15.59
3	Honey Bees	80	30.42
4	Wasps	42	15.97
	Total	263	100.00

Symplocos cochinchinensis

A total of 522 individuals belonging to 4 species were recorded on *Symplocos cochinchinensis*. The most frequent flower visitors were flies (n=188), followed by honey bees (n=179) and butterflies (n=100) (Table 8).

Table 8. Insect pollinators of *Symplocos cochinchinensis*

S.No	Name of Insect	No of visits	%
1	Butterflies	100	19.16
2	Flies	188	36.02
3	Honey Bees	179	34.29
4	Other Bees	55	10.54
	Total	522	100.00

Syzygium cumini

A total of 583 individuals belonging to 5 species were recorded in the plant of *Syzygium cumini*. The most frequent flower visitors were honey bees (n=232), followed by carpenter bees (n=117) and butterflies (n=109) (Table 9).

Table 9. Insect pollinators of *Syzygium cumini*

S.No	Name of Insect	No of visits	%
1	Butterflies	109	18.70
2	Carpenter Bees	117	20.07
3	Honey Bees	232	39.79
4	Flies	67	11.49
5	Wasps	58	9.95
	Total	583	100.00

Syzygium tamilnadensis

A total of 740 individuals belonging to 5 species were recorded in the plant of *Syzygium montana*. The most frequent flower visitors were butterflies (n=214), followed by flies (n=208) and honey bees (n=187) (Table 10).

Table 10. Insect pollinators of *Syzygium tamilnadensis*

S.No	Name of Insect	No of visits	%
1	Butterflies	214	28.92
2	Flies	208	28.11
3	Honey Bees	187	25.27
4	Other Bees	92	12.43
5	Wasps	39	5.27
	Total	740	100.00

Glochidion neilgherrensis

A total of 274 individuals belonging to three species were recorded in the plant of *Glochidion neilgherrensis*. The most frequent flower visitors were butterflies (n=110), followed by honey bees (n=98) and other bees (n=66) (Table 11).

Table 11. Insect pollinators of *Glochidion neilgherrensis*

S.No	Name of Insect	No of visits	%
1	Butterflies	110	40.15
2	Honey Bees	98	35.77
3	Other Bees	66	24.09
	Total	274	100.00

Ixora notoniana

A total of 162 individuals belonging to three insect groups visited *Ixora notoniana*. The most frequent flower visitors were honey bees (n=112), followed by flies (n=28), butterflies (n=22) (Table 12).

Table 12. Insect Pollinators of *Ixora notoniana*

S.No	Name of Insect	No. of visits	%
1	Honey Bees	112	69.14
2	Butterflies	22	13.58
3	Flies	28	17.28
	Total	162	100.00

Euonymus dichotomous

A total of 314 individuals belonging to three insect groups visited *Euonymus dichotomous*. The most frequent flower visitors were *Apis florea* (n=134) followed by flies (n=98) and butterflies (n=82) (Table 13).

Table 13. Insect Pollinators of *Euonymus dichotomous*

S.No	Name of Insect	No. of visits	%
1	<i>Apis florea</i>	134	42.68
2	Butterflies	82	26.11
3	flies	98	31.21
	Total	314	100.00

Phoebe lanceolata

A total of 217 individuals belonging to three insect groups visited *Phoebe lanceolata*. The most frequent flower visitors were *Apis cerana* (n=120), followed by wasps (n=55), flies (n=42) (Table 14)

Table 14. Insect Pollinators of *Phoebe lanceolata*

S.No	Name of Insect	No. of visits	%
1	<i>Apis cerana</i>	120	55.30
2	Wasps	55	25.35
3	flies	42	19.35
	Total	217	100.00

Evodia lunu-ankenda

A total of 344 individuals belonging to five insect groups visited *Euodia lunu-ankenda*. The most frequent flower visitors were butterflies (n=149) followed by honey bees (n=101) and flies (n=94) (Table 15).

Table 15 Insect Pollinators of *Euodia lunu-ankenda*

S.No	Name of Insect	No of visits	%
1	Butterfly	149	43.31
2	Honey Bee	101	29.36
3	fly	94	27.33
	Total	344	100.00

Ligustrum perrottetii

A total of 608 individuals belonging to five insect groups visited *Ligustrum perrottetii*. The most frequent flower visitors were butterflies (n=219), followed by honey bees (n=160) and wasps (n=84) (Table 16).

Table 16. Insect Pollinators of *Ligustrum perrottetii*

S.No	Name of Insect	No of visits	%
1	Honey Bees	160	26.32
2	Butterflies	219	36.02
3	Wasps	84	13.82
4	Beetles	63	10.36
5	flies	82	13.49
	Total	608	100.00

Daphniphyllum neilgherrense

A total of 336 individuals belonging to four insect groups visited *Daphniphyllum neilgherrense*. The most frequent flower visitors were butterflies (n=182) followed by honey bees (n=72) and wasps (n=42) (Table 17).

Table 17. Insect Pollinators of *Daphniphyllum neilgherrense*

S.No	Name of Insect	No of visits	%
1	Butterflies	182	54.17
2	Honey Bees	72	21.43
3	Wasps	42	12.50
4	Flies	40	11.90
	Total	336	100.00

Dry deciduous forest : Pachamalai hills

Pachamalai

The Pachamalai hills are situated at the central region of Tamil Nadu, India, with latitudes $11^{\circ} 15'N$ and longitudes of $76^{\circ} 38' E$. They occupy an area of about 527.61 sq. km and the altitude ranges from 160 to 1072 m msl. The vegetated area is distributed in 35 reserved forests. The Pachamalai hills enjoy a sub-tropical climate with temperatures varying from $25^{\circ}C$ to $31^{\circ} C$ and annual rainfall ranging from 800 to 900 mm. The total tribal population is around 12,000 who live in 70 hamlets scattered all over the plateau area. Pachamalai is rich in flora and fauna. Important mammalian species found here are Spotted deer, Hyena, Sloth Bear and Bonnet Macaque.

Methodology

Vegetation Survey

Vegetation sampling was done in Pachamalai in two habitat types namely undisturbed, disturbed dry deciduous forest stands. Quadrat method was used for sampling. Two plots of 100 X 100m were laid in each of the above two habitats. A total of 2 ha were sampled. In each of the plot number of individuals of trees and GBH >20 cm were noted. Plants measuring $20 >$ cm GBH were considered as trees. The data collected were analysed to obtain quantitative structure and composition of plant communities. Density value was calculated for each species following Curtis and McIntosh (1950). The relative value of density was determined as per Philips (1959).

Species identification was done following the regional floras and counter checked with the help of Herbaria of the Botanical Survey of India, Southern Circle, Coimbatore.

Density is defined as the number of individuals of a species in a unit area and is an expression of the numerical strength of a species in a community. The density was calculated as follows.

$$\text{Density} = \frac{\text{Total number of individuals}}{\text{Total number of quadrats studied}}$$

Relative density (RD) is the study of numerical strength of a species in relation to total number of all species and is calculated as follows;

$$\text{Relative Density} = \frac{\text{Number of individuals of a species}}{\text{Number of individuals of all species}} \times 100$$

RESULTS

Trees

A total of 71 woody species belonging to 19 families were recorded during the vegetation sampling. Of these 43 were tree species and 28 shrub species. The diversity of plant families was higher in undisturbed site (n=13) than the disturbed site (n=10). A total of 1432 trees were found in undisturbed site. Maximum number of individuals was recorded for *Pleiospermium alatum* (n=228) followed by *Atalantia monophylla* (n=217) and *Chloroxylon sweitenia* (n=124) (Table 18). In the disturbed forest stand 732 trees were found. Among them, maximum values was recorded for *Acacia nilotica* (n=226) followed by *Tamarindus indica* (n=133) and *Chloroxylon sweitenia* (n=102) (Table 1). In the undisturbed site, maximum value for density was observed for *Pleiospermium alatum* (2.28) followed by *Atalantia monophylla* (2.17) and *Chloroxylon sweitenia* (1.24). Relative density was found to be maximum for *Pleiospermium alatum* (15.92) followed by *Atalantia monophylla* (15.15) and *Chloroxylon swietenia* (8.66) in the undisturbed site (Table 1). In the disturbed forest, density values were maximum for *Acacia nilotica* (Density 2.28) followed by *Tamarindus indica* (1.33) and *Chloroxylon swietenia* (1.02). Relative density was maximum for *Acacia nilotica* (30.87) followed by *Tamarindus indica* (18.17) and *Chloroxylon swietenia* (13.93) (Table 19).

Table 18. Tree density values in the undisturbed forest site in Pachamalai hills

S.No	Plant Name	No. of individuals	Density	Relative density
1	<i>Acacia leucophloea</i>	29	0.29	2.03
2	<i>Acacia nilotica</i>	106	1.06	7.40
3	<i>Ailanthus excelsa</i>	25	0.25	1.75
4	<i>Albizia amara</i>	86	0.86	6.01
5	<i>Albizia lebbeck</i>	8	0.08	0.56
6	<i>Alseodaphne semecarpifolia</i>	5	0.05	0.35
7	<i>Atalantia monophylla</i>	217	2.17	15.15
8	<i>Azadirachta indica</i>	48	0.48	3.35
9	<i>Bauhinia racemosa</i>	69	0.69	4.82
10	<i>Canthium dicoccum</i>	100	1	6.98
11	<i>Chloroxylon swietenia</i>	124	1.24	8.66
12	<i>Cleistanthus collinus</i>	2	0.02	0.14
13	<i>Dalbergia latifolia</i>	2	0.02	0.14
14	<i>Erythroxylum monogynum</i>	39	0.39	2.72
15	<i>Holoptelea integrifolia</i>	4	0.04	0.28
16	<i>Ixora arborea</i>	17	0.17	1.19
17	<i>Mallotus sp.</i>	6	0.06	0.42
18	<i>Morinda tinctoria</i>	40	0.4	2.79
19	<i>Pleiospermium alatum</i>	228	2.28	15.92
20	<i>Prosopis juliflora</i>	5	0.05	0.35
21	<i>Randia dumetorum</i>	34	0.34	2.37
22	<i>Strchnos potatorum</i>	69	0.69	4.82
23	<i>Tamarindus indica</i>	64	0.64	4.47
24	<i>Zizyphus oenoplia</i>	83	0.83	5.80
25	<i>Zizyphus mauritiana</i>	22	0.22	1.54

Table 19. Tree density values in the disturbed site of the Pachamalai hills

S.No	Plant Name	No. of individuals	Density	Relative density
1	<i>Acacia chundra</i>	12	0.12	1.64
2	<i>Acacia leucophloea</i>	24	0.24	3.28
3	<i>Acacia nilotica</i>	226	2.26	30.87
4	<i>Albizia amara</i>	29	0.29	3.96
5	<i>Albizia lebbbeck</i>	5	0.05	0.68
6	<i>Azadirachta indica</i>	81	0.81	11.07
7	<i>Bauhinia racemosa</i>	5	0.05	0.68
8	<i>Canthium dicoccum</i>	7	0.07	0.96
9	<i>Chloroxylon swietenia</i>	102	1.02	13.93
10	<i>Dalbergia latifolia</i>	7	0.07	0.96
11	<i>Erythroxylum monogynum</i>	11	0.11	1.50
12	<i>Pavetta indica</i>	1	0.01	0.14
13	<i>Prosopis juliflora</i>	9	0.09	1.23
14	<i>Randia dumetorum</i>	29	0.29	3.96
15	<i>Tamarindus indica</i>	133	1.33	18.17
16	<i>Wrightia tinctoria</i>	4	0.04	0.55
17	<i>Zizyphus mauritiana</i>	26	0.26	3.55
18	<i>Zizyphus oenoplia</i>	21	0.21	2.87

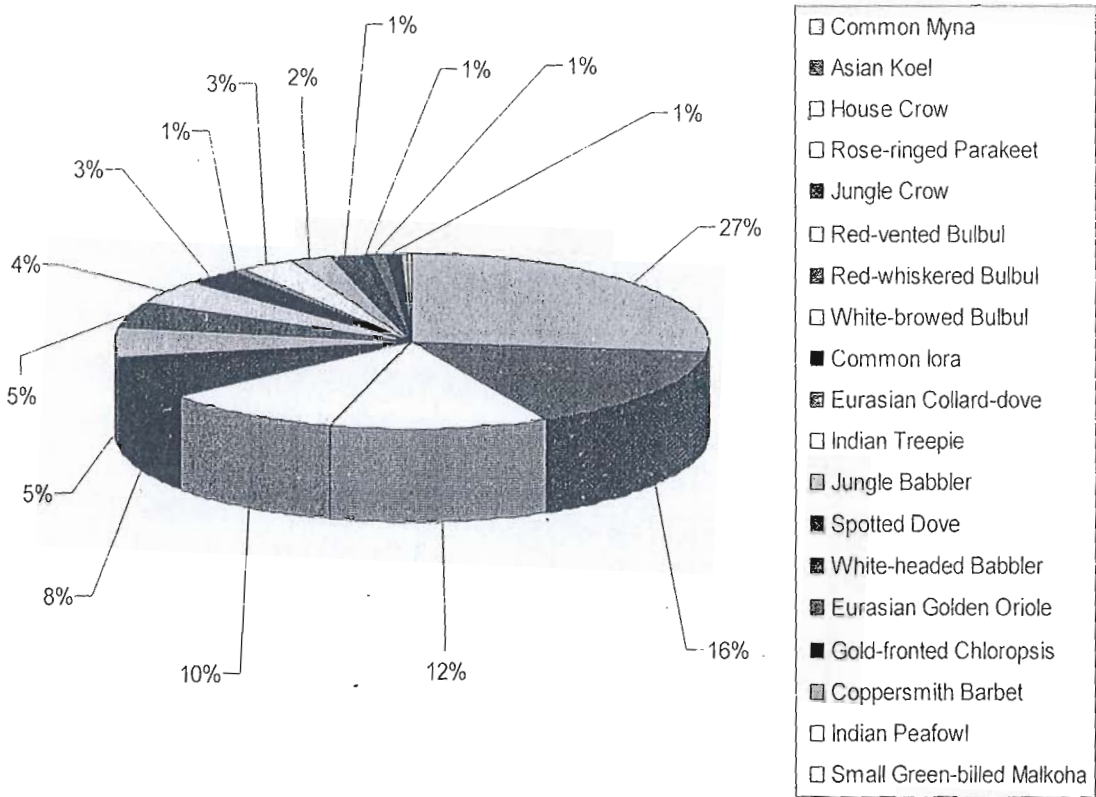
Table 20. Phenology profile of trees in the Dry deciduous Forests of Pachamalai Hills (Oct. 2008-Nov. 2009)

S.No	Plant Name	Oct		Nov		Dec		Jan		Feb		Mar		Apr		May		June		July		Aug		Sep		Oct		Nov	
		Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr	Fl	Fr
1	<i>Acacia leucophloea</i>	+	-	+	+	-	-	+	+	+	+	-	+	+	+	+	+	-	-	+	+	-	-	+	+	-	-	+	+
2	<i>Albizia lebeck</i>	-	-	-	-	-	-	-	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-
3	<i>Azadirachta indica</i>	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-	-	+	+	+	+	-	+	+	+	+	+	-	-
4	<i>Bauhinia racemosa</i>	-	-	-	+	-	-	+	+	-	-	-	+	-	+	+	+	-	-	-	-	-	-	-	-	+	+	-	+
5	<i>Canthium dicoccum</i>	-	-	-	-	-	-	-	+	+	+	+	+	+	+	-	-	-	-	+	+	-	-	-	-	+	+	-	-
6	<i>Capparis grandis</i>	+	-	+	+	-	-	+	+	-	-	+	+	-	-	+	+	-	-	-	-	-	-	+	+	+	+	-	-
7	<i>Celtis philippensis</i>	-	-	-	+	-	-	-	-	-	-	+	+	+	+	-	-	-	-	+	+	-	-	+	+	-	-	-	-
8	<i>Choloroxylon swietenia</i>	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
9	<i>Cordia monoica</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-	+	+	+	+	-	-
10	<i>Dalbergia latifolia</i>	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-
11	<i>Diospyros montana</i>	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
12	<i>Erythroxylum monogynum</i>	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	-	-	-	-	-	-	+	+	-	-	-	-
13	<i>Feronia elephantum</i>	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	+	+	-	-	-
14	<i>Ficus microcarpa</i>	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	<i>Ficus racemosa</i>	-	+	-	+	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	<i>Holoptelia integrifolia</i>	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	<i>Ixora pavetta</i>	-	-	-	+	-	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	<i>Morinda tinctoria</i>	-	-	-	-	-	-	+	+	-	-	-	+	+	+	+	+	-	-	-	-	+	+	-	-	-	-	-	-
19	<i>Naringi crenulata</i>	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
20	<i>Pleiospermium alatum</i>	-	-	-	+	-	-	-	-	-	-	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
21	<i>Santalum album</i>	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
22	<i>Strychnos potatorum</i>	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-
23	<i>Syzygium cumini</i>	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	-	-	-	-	+	+	-	-	-	-	-	-
24	<i>Tamarindus indica</i>	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-
25	<i>Zizyphus mauritiana</i>	-	-	-	+	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
26	<i>Zizyphus oenoplia</i>	-	-	-	+	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+

Fruit eating birds observed in the dry deciduous forest of Pachamalai Hills

A total of 12 plants species were observed to record the frugivores in the dry deciduous forests of Pachamalai. 4317 individuals belonging to 19 species of frugivorous birds were observed in the dry deciduous forest. Among the frugivores recorded, Common Myna (27.14%) followed by Asian Koel (15.18%) and House Crow (12.01%) were found to be the requent visitors. Common Myna and Asian Koel appear to be the principal seed dispersers in the dry deciduous forest. Common Myna visited all the 10 species but Asian Koel visited only 4 plant species. Most of the avian frugivores were attracted by *Ficus benghalensis* (n=13) followed by *Canthium dicoccum* (n=9) and *Syzygium cumini* (n=8) (Fig. 33).

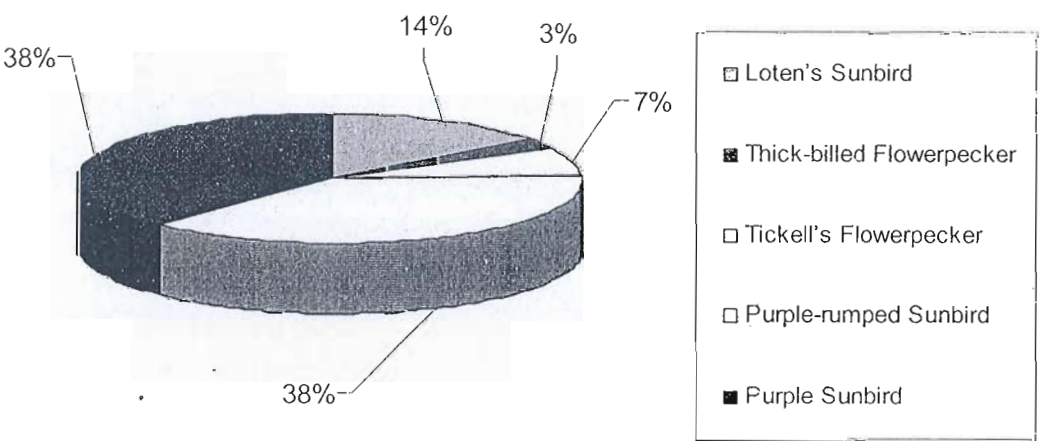
Fig. 33 Avian Frugivores in the dry deciduous forests, Pachamalai hills



Nectar feeding birds observed in the Dry deciduous forest of Pachamalai hills

Five plant species were observed for recording the nectarivorous bird in the dry deciduous forest of Pachamalai. A total of 2280 individuals belonging to 6 species of nectarivorous birds were recorded. Maximum number of individuals of nectarivores observed include Purple Subird (37.98%) followed by Purple-rumped Sunbird (37.94%) and Loten’s Sunbird (14.34%). Purple Sunbird and Purple-rumped Sunbird visited 5 plant species in the dry deciduous forest. These species appear to play an important role in the pollination of trees in the dry deciduous forest. Maximum number of nectar feeding bird species visited *Feronia elephantum* (n=5) , *Chloroxylon swietenia* (n=5) and *Azadirachta indica* (n=4) (Fig. 34)

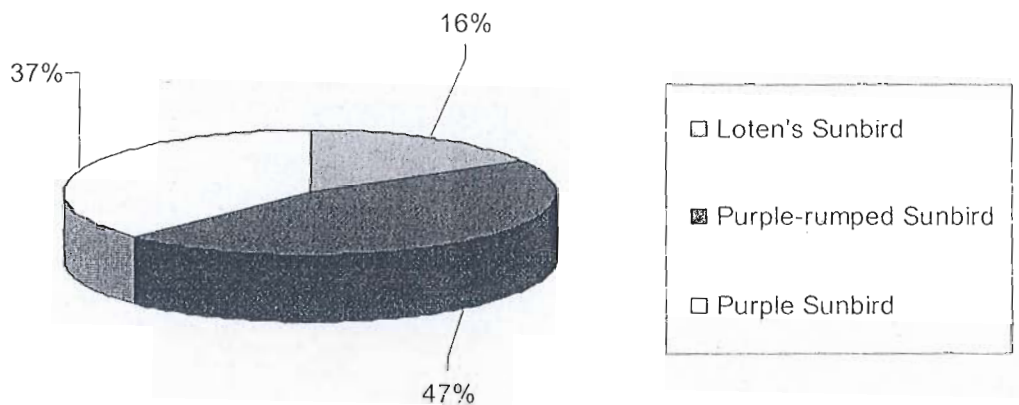
Fig. 34 Nectativores in the dry deciduous forests, Pachamalai hills.



Tamarindus indica

A total of 902 individuals belonging to 3 species nectarivorous birds were recorded. Majority of nectarivores recorded include Purple-rumped Sunbird (46.23%) followed by Purple Sunbird (37.36%) and Loten's Sunbird (16.40%) (Fig. 35)

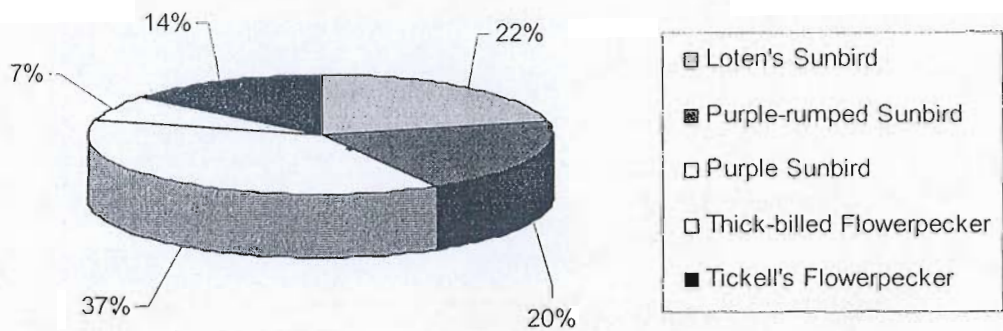
Fig. 35 Nectarivorous bird visits to *Tamarindus indica*



Choloroxylon swietenia

A total of 278 individuals belonging to 5 species of nectarivores were recorded. Major nectarivores include Purple Sunbird (37.05%) followed by Loten's Sunbird (21.58%) and Purple-rumped Sunbird (20.14%) (Fig. 36)

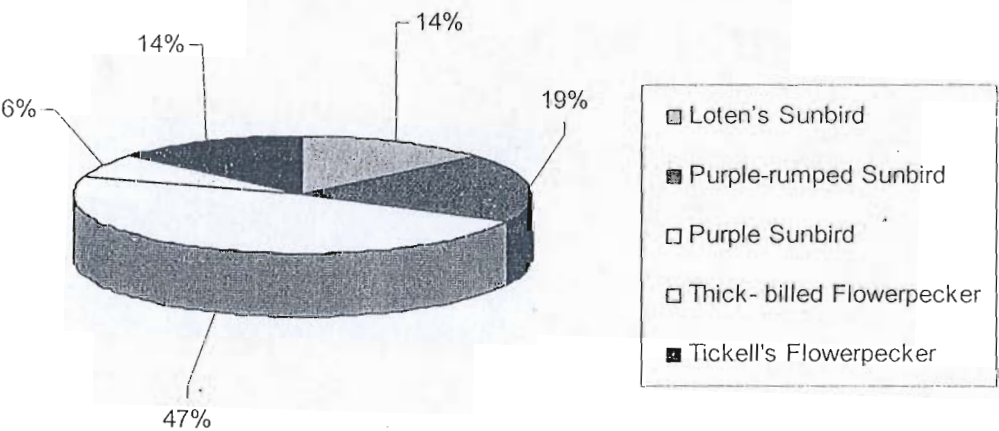
Fig. 36. Nectarivorous bird visits to *Choloroxylon swietenia*



Feronia elephantum

A total of 317 individuals belonging to 5 species of nectarivorous birds were recorded. Most frequent visitors include Purple Sunbird (47.63%) followed by Purple-rumped Sunbird (18.93%), Loten's Sunbird (13.56%) and Tickell's Flowerpecker (13.56%) (Fig. 37).

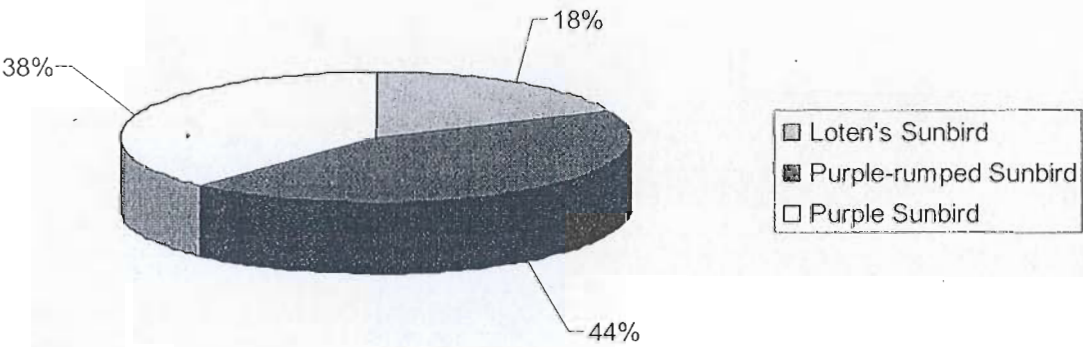
Fig 37. Nectarivorous bird visits to *Feronia elephantum*



Albizia amara

A total of 415 individuals belonging 3 species of nectarivorous birds were recorded. Most frequent visitors nectarivores observed include Purple-rumped Sunbird (43.62%) followed by Purple Sunbird (38.80%) and Loten's Sunbird (18.31%) (Fig. 38).

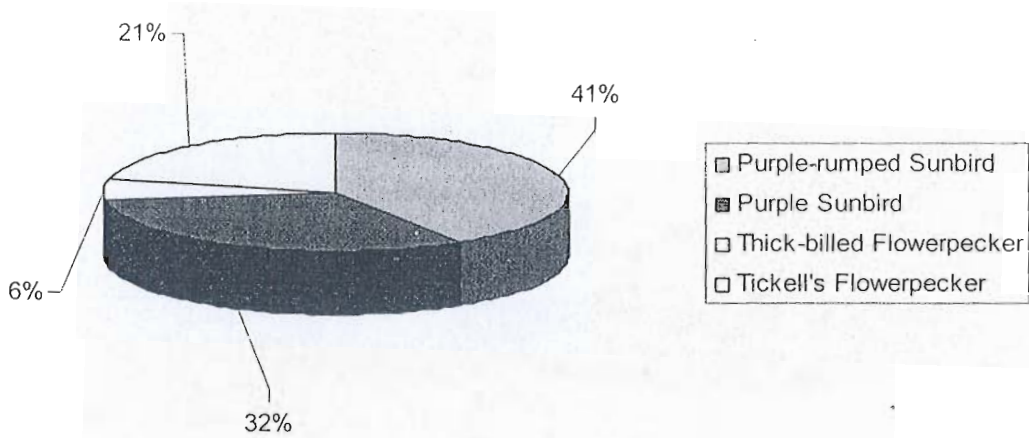
Fig. 38. Nectarivorous bird visits to *Albizia amara*



Azadirachta indica

A total of 368 individuals belonging to 4 species of nectarivorous birds were recorded. Majority of the nectarivores observed include Purple-rumped Sunbird (41.03%) followed by Purple Sunbird (31.79%) and Tickell's Flowerpecker (21.47%) (Fig. 39)

Fig. 39. Nectarivorous bird visits to *Azadirachta indica*

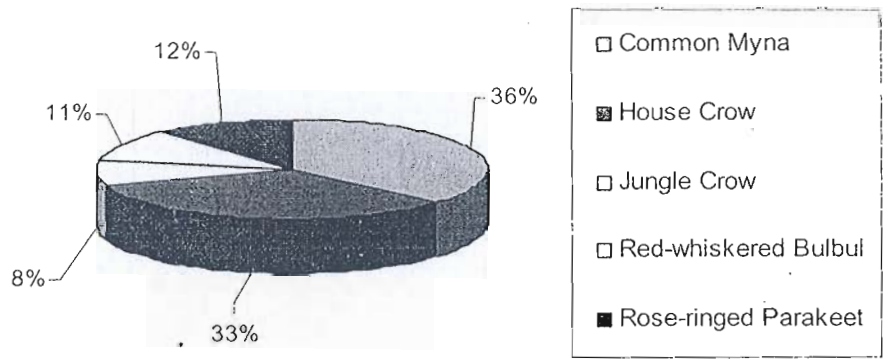


Frugivorous birds in the Dry deciduous forests of Pachamalai hills

Azadirachta indica

A total of 448 individuals belonging to 5 species of frugivorous bird species were recorded. Maximum number of frugivores observed include Common Myna (36.05%) followed by House Crow (32.59%) and Rose-ringed Parakeet (11.61%) (Fig. 40).

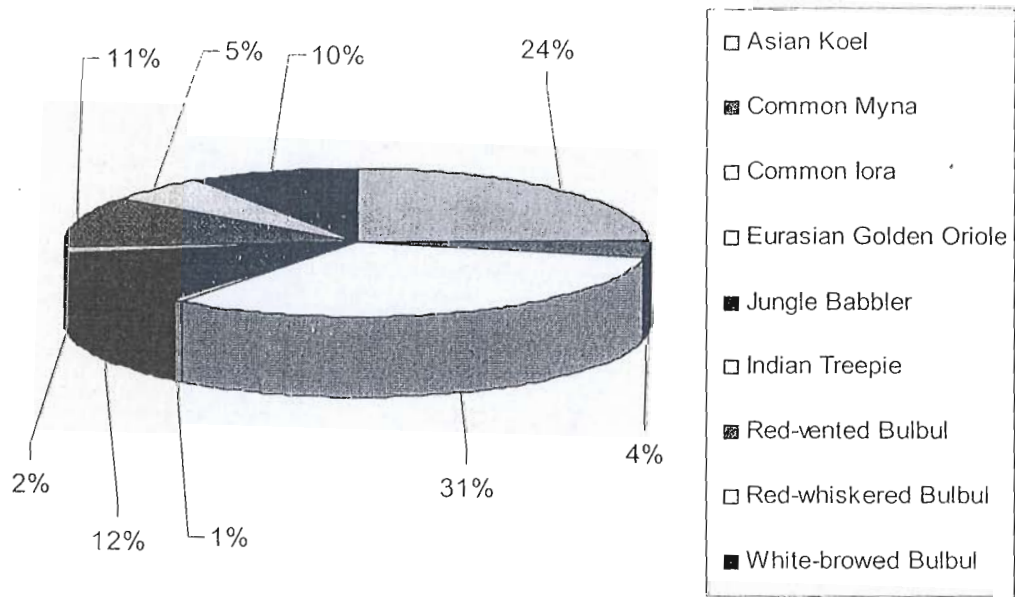
Fig. 40. Frugivorous bird visits to *Azadirachta indica*



Canthium dicoccum

A total of 388 individuals belonging to 9 species of frugivores were recorded. Most frequently visited frugivores include Common Myna (31.96%) followed by Asian Koel (24.48%) and Jungle Babbler (11.60%) (Fig. 41).

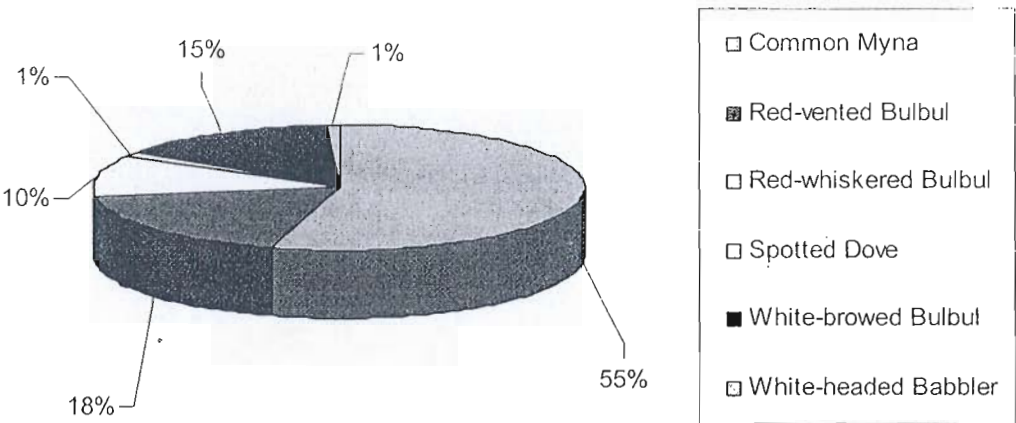
Fig. 41 Frugivorous bird visits to *Canthium dicoccum*



Celtis philippensis

A total of 500 individuals belonging to 6 species of frugivores were recorded. Most frequently visited frugivores include Common Myna (55%) followed by Red-vented Bulbul (18.40%) and White-browed Bulbul (15%) (Fig. 42).

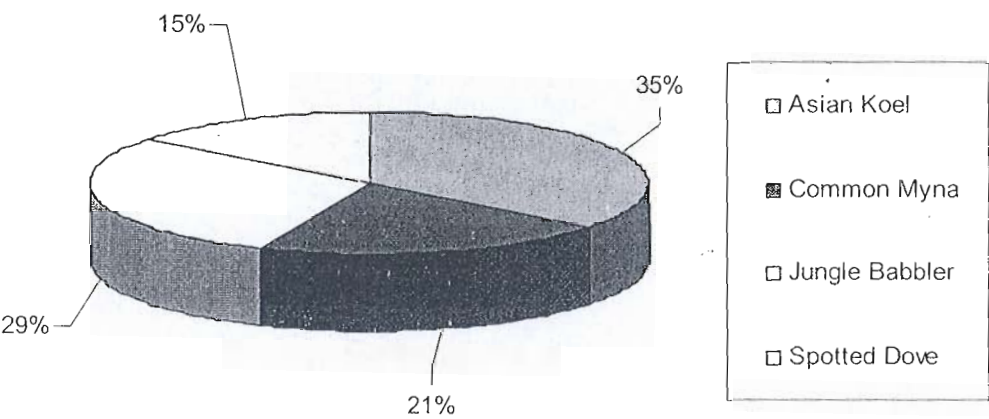
Fig. 42. Frugivorous bird visits to *Celtis philippensis*



Erythroxylum monogynum

A total of 110 individuals belonging to 4 species were recorded. Most frequently visited frugivores include Asian Koel (35.45 %) followed by Jungle Babbler (29.09%) and Common Myna (20.91) (Fig. 43).

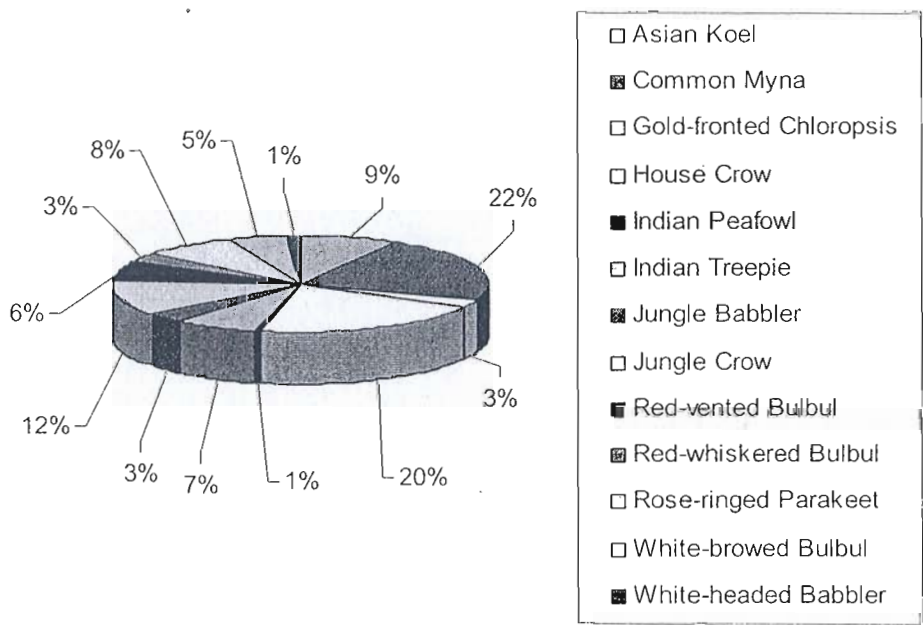
Fig. 43 Frugivorous bird visits to *Erythroxylum monogynum*



Ficus bengalensis

A total of 719 individuals belonging to 13 species of frugivores visited. Maximum number of frugivores recorded include Common Myna (22.02%) followed by House crow (19.94%) and Jungle Crow (8.59%) (Fig. 44).

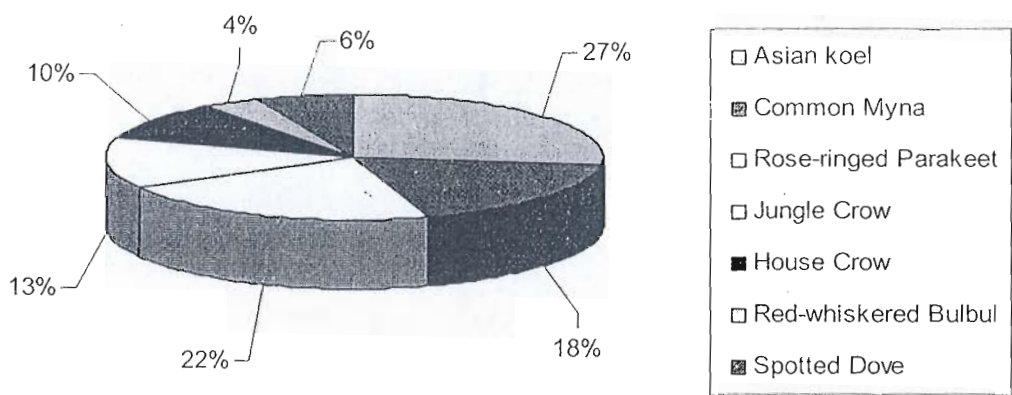
Fig. 44 Frugivorous bird visits to *Ficus bengalensis*



Ficus microcarpa

A total of 644 individuals belonging to 7 species of frugivores visited. Most frequently visited frugivores include Asian Koel (27.17%) followed by Rose-ringed Parakeet (21.58%) and Common Myna (18.01%) (Fig. 45).

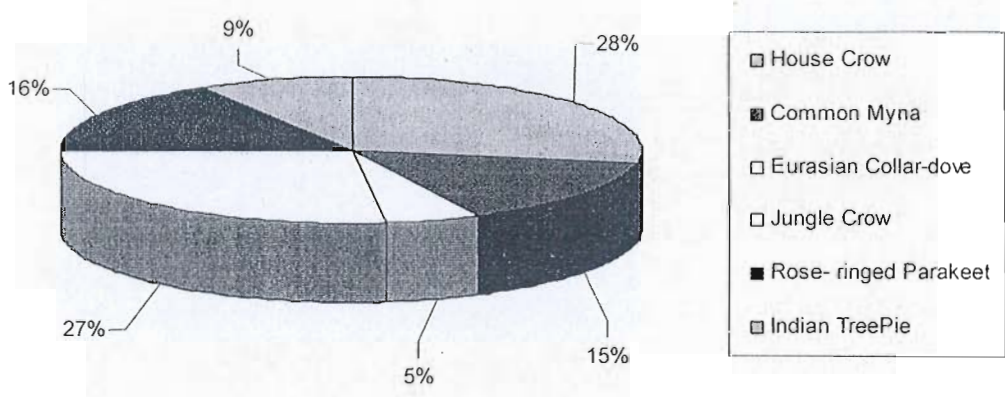
Fig. 45 Frugivorous bird visits to *Ficus microcarpa*



Ficus racemosa

A total of 571 individuals belonging to 6 species of frugivores visited. Most frequently visited frugivores include House Crow (28.10%) followed by Jungle crow (14.60%) and Rose-ringed Parakeet (16.45%) (Fig. 46)

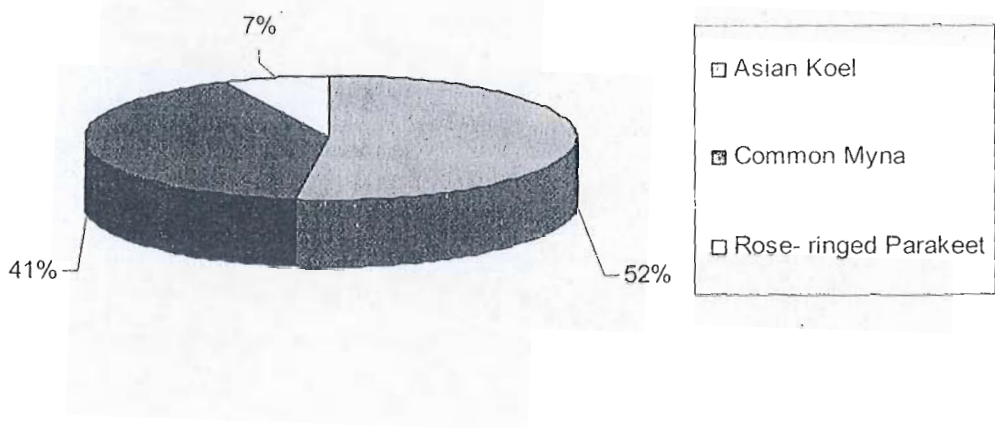
Fig. 46 Frugivorous bird visits to *Ficus racemosa*



Santalum album

A total of 426 individuals belonging to 3 species visited. Most frequently visited frugivores include Asian Koel (52.11%) followed by Common Myna (41.08%) and Rose-ringed Parakeet (6.81%) (Fig. 47).

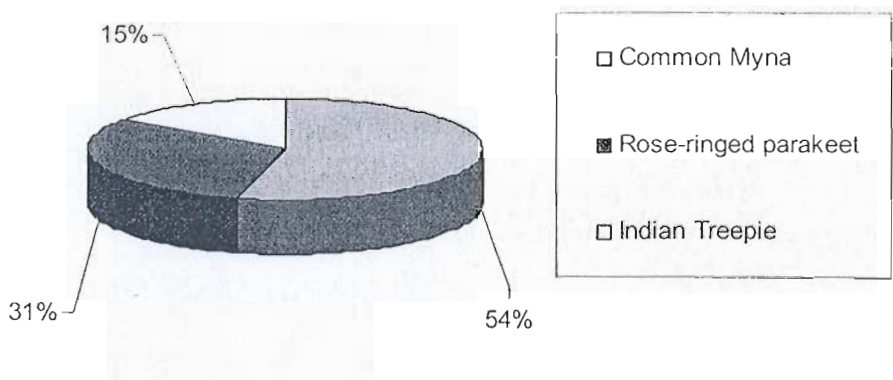
Fig. 47. Frugivorous bird visits to *Santalum album*



Zizyphus oenoplia

A total of 126 individuals belonging to 3 species of frugivores visited. Most frequently visited frugivores Common Myna (53.97%) followed by Rose-ringed Parakeet, (30.95 %) and Indian Treepie (15.08%) (Fig. 48).

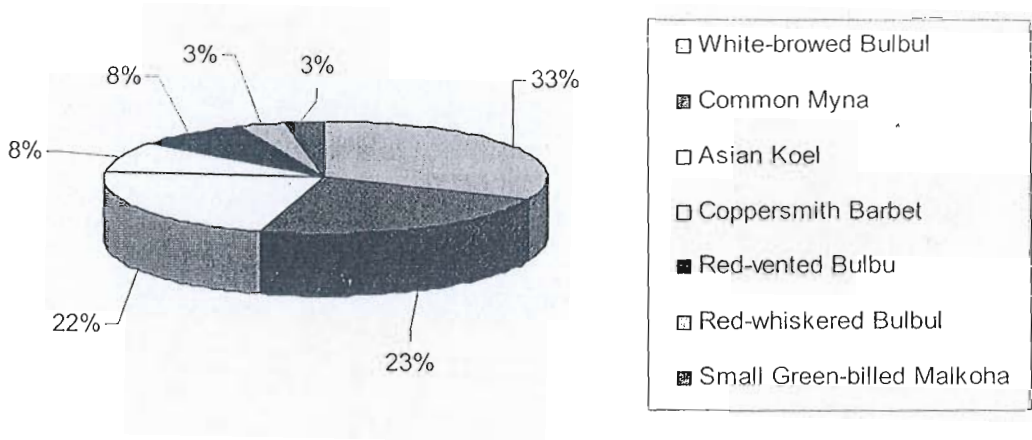
Fig. 48. Frugivorous bird visits to *Zizyphus oenoplia*



Diospyros montana

A total of 95 individuals belonging to 7 species of frugivores visited. Most frequently visited frugivores White-browed Bul bul (31.58), Common Myna (23.16) followed by Asian Koel (22.11%) (Fig. 49)

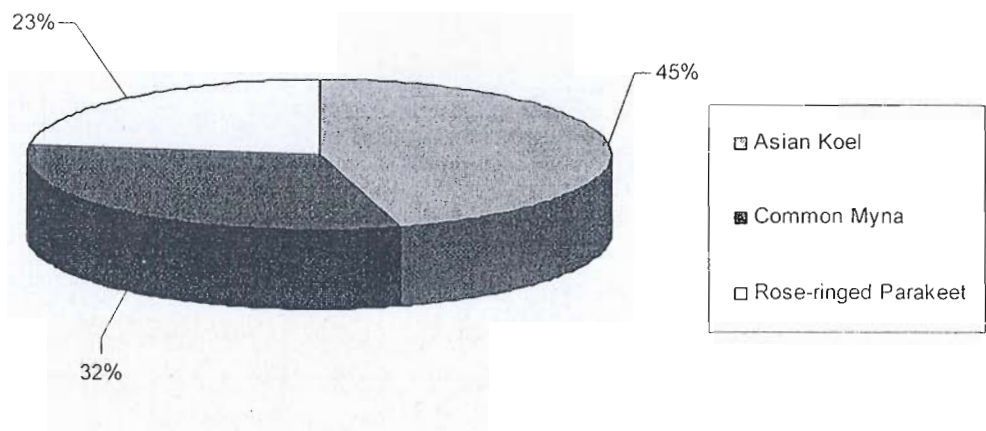
Fig. 49. Frugivorous bird visits to *Diospyros montana*



Morinda tinctoria

A total of 66 individuals belonging to 3 species of frugivores visited. Most frequently visited frugivores Asian Koel (45.45%) , Common Myna (31.82%) followed by Rose-ringed Parakeet (22.73%). (Fig. 50).

Fig. 50. Frugivorous bird visits to *Morinda tinctoria*

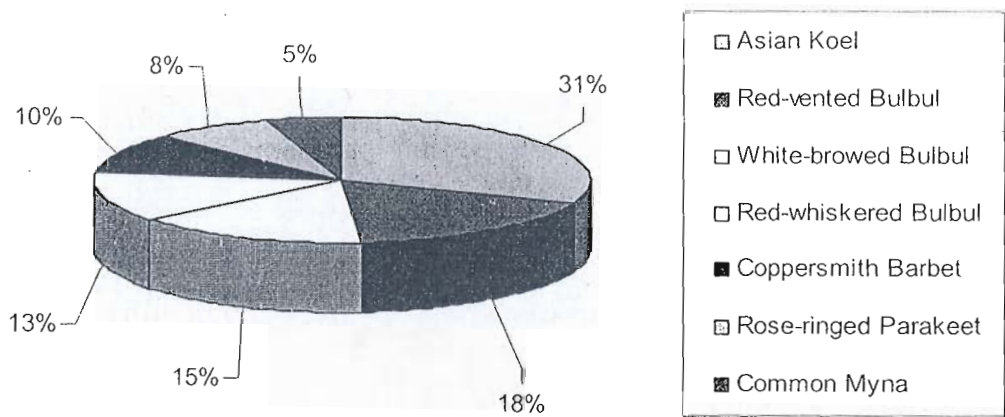


Frugivorous birds observed at some shrub plants in Pachamalai hills

Scutia myrtina

A total of 39 individuals belonging to 7 species of frugivores visited. Most frequently visited frugivores Asian Koel (30.77%) followed by Red-vented Bulbul (17.95) and White-browed Bulbul (15.38) (Fig. 51).

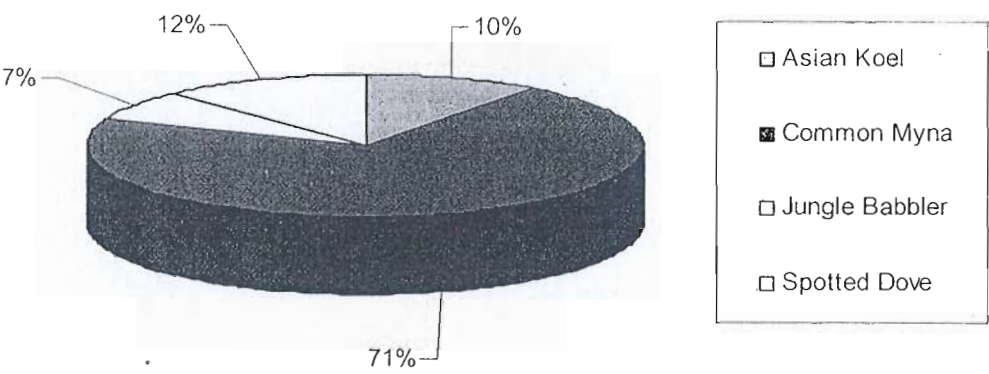
Fig. 51. Frugivorous bird visits to *Scutia myrtina*



Carissa carandas

A total of 298 visits were made by frugivores. Most frequently visited frugivores were Common Myna (70.47%) followed by Spotted Dove (12.08%) and Asian Koel (10.40%) (Fig. 52).

Fig. 52. Frugivorous bird visits to *Carissa carandas*



INSECT POLLINATORS - PACHAMALAI

Insect visitors to various plant species

A total of 6626 visits were made by 8 groups of insect pollinators in the dry deciduous forests of Pachamalais. Maximum number of pollinators were attracted by *Feronia elephantum* (n=2920) followed by *Erythroxylum monogynum* (n=596) and *Terminalia arjuna* (n=556) (Table 21).

Table 21 Insect visitors to various plant species in the dry deciduous forests

S.No	Insect Name	A.I	A.A	M.T	F.E	T.A	C.S	M.I	T.I	E.M	D.M	No of visits	%
1	Butterfly	180	129	111	-	100	134	31	17	301	213	1216	18.35
2	flies	-	-	-	-	198	26	158	-	-	-	382	5.77
3	Beetle	-	43	22	-	-	-	12	-	-	-	77	1.16
4	Honey Bee	123	136	88	2841	-	141	84	113	72	92	3690	55.69
5	Other Bees	40	56	52	42	66	67	15	92	223	-	653	9.86
6	Wasp	-	-	-	37	-	-	-	-	-	-	37	0.56
7	Ants	-	-	102	-	192	-	208	-	-	-	502	7.58
8	Moth	-	-	-	-	-	-	-	69	-	-	69	1.04
	Total	343	364	375	2920	556	368	508	291	596	305	6626	100.00

A.I = *Azadirachta indica*, *A.A* = *Albizia amara*, *F.E* = *Feronia elephantum*,
T.A = *Terminalia arjuna*, *C.S* = *Chloroxylon sweitenia*, *M.I* = *Mangifera indica*,
T.I = *Tamarindus indica*, *E.M* = *Erythroxylum monogynum*,
D.M = *Diospyros montana*, *M.T* = *Morinda tinctoria*.

BUTTERFLY ATTRACTING PLANTS IN THE DRY DECIDUOUS FOREST (PACHAMALAI)

A total of 1254 individuals belonging to 15 butterfly species on 9 plant species were observed in the dry deciduous forest of Pachamalai. Major butterfly attracting plants include *Erythroxylon monogynum* followed by *Double Banded Crow* (n=92), *Common Mormon* (n=93), *Common Fivering* (n=77), *Indian Cabbage White* (n=17), *Blue Tiger* (n=22), were observed than the other plant species (Table 22).

Table 22 Lepidopteran visitors to various plant species in Pachamalai

Name of the Plants	C.R	D.B.C	Y.O.T	P.T	L.B	C.S	P.O.T	W.O.T	C.E	G.B.T	C.M	Mo	C.F	I.C.W	B.T	No of visits	%
<i>Azadirachta indica</i>	-	180	-	-	-	-	-	-	-	-	-	-	-	-	-	180	14.35
<i>Albizia amara</i>	67	-	-	-	-	-	-	-	-	-	62	-	-	-	-	129	10.29
<i>Microtropis densiflora</i>	-	-	40	-	-	22	-	12	-	37	-	-	-	-	-	111	8.85
<i>Terminalia arjuna</i>	-	62	-	16	-	-	-	-	-	22	-	-	-	-	-	100	7.97
<i>Chloroxylon swietenia</i>	-	25	-	33	34	-	-	42	-	-	-	-	-	-	-	134	10.69
<i>Mangifera indica</i>	-	-	-	-	-	-	9	-	22	-	-	-	-	-	-	31	2.47
<i>Tamarindus indica</i>	-	-	-	-	17	-	-	-	-	-	-	69	-	-	-	86	6.86
<i>Erythroxylon monogynum</i>	-	92	-	-	-	-	-	-	-	-	93	-	77	17	22	301	24.00
<i>Diospyros montana</i>	-	106	-	-	-	-	-	-	-	-	76	-	-	-	-	182	14.51
Total	67	465	40	49	51	22	9	54	22	59	231	69	77	17	22	1254	100.00

C.M = Common Mormon, Mo=Moth, C.F=Common Fivering, I.C.W=Indian Cabbage White, B.T=Blue Tiger

P.T = Plain Tiger, L.B = Lime Butterfly, C.S = Common Sailor, P.O.T = Plain Orange Tip,

W.O.T = White Orange Tip, C.E = Common Emigrant, G.B.T = Glassy Blue Tiger,

C.R = Common Rose, D.B.C = Double Banded Crow, Y.O.T = Yellow Orange Tip,

INSECT POLLINATORS OF DRY DECIDUOUS FOREST

Azadirachta indica

A total of 343 visits were made by three insect groups. The most frequent flower visitors were butterflies (n=180) followed by honey bees (n=123) and Carpenter bees (n=40) (Table 23).

Table 23 Insect pollinators of *Azadirachta indica*

S.No	Name of Insect	No of visits	%
1	Butterflies	180	52.48
2	Carpenter Bees	40	11.66
3	Honey Bees	123	35.86
	Total	343	100

A total of 364 visits were made by insect four groups. Most frequent flower visitors were honey bees (n=136) followed by butterflies (n=129) and Carpenter bees (n=56) (Table 24).

Table 24. Insect pollinators of *Albizia amara*

S.No	Name of Insect	No of visits	%
1	Butterflies	129	35.44
2	Carpenter Bees	56	15.38
3	Honey Bees	136	37.36
4	Beetles	43	11.81
	Total	364	100.00

Morinda tinctoria

A total of 375 visits were made by five insect groups individuals belonging to 5 speciesm Most frequent visits were made by butterflies (n=111) followed by honey bees (n=88) and Carpenter bees (n=52) (Table 25).

Table 25. Insect pollinators of *Morinda tinctoria*

S.No	Name of Insect	No of visits	%
1	Butterflies	111	29.60
2	Carpenter Bees	52	13.87
3	Ants	102	27.20
4	Honey Bees	88	23.47
5	Beetles	22	5.87
	Total	375	100.00

Feronia elephantum

A total of 2920 visits were made by three insect groups. Most frequent flower visitors were honey bees (n=2841) followed by Carpenter bees (n=42) and wasps (n=37) (Table 26).

Table 26. Insect pollinators of *Feronia elephantum*

S.No	Name of Insect	No of visits	%
1	Carpenter Bees	42	1.44
2	Honey Bees	2841	97.29
3	wasps	37	1.27
	Total	2920	100

Terminalia arjuna

A total of 556 visits were made by four insect groups. The most frequent flower visitors were flies (n=198) followed by butterflies (n=100) and other bees (n=66) (Table 27).

Table 27. Insect pollinators of *Terminalia arjuna*

S.No	Name of Insect	No of visits	%
1	Butterflies	100	17.99
2	Flies	198	35.61
3	Other Bees	66	11.87
4	Ants	192	34.53
	Total	556	100.00

A total of 368 visits were made by four insect groups. The most frequent flower visitors were honey bees (n=141) followed by butterflies (n=134) and Carpenter bees (n=67) (Table 28).

Table 28. Insect pollinators of *Chloroxylon swietenia*

S.No	Name of Insect	No of visits	%
1	Butterflies	134	36.41
2	Flies	26	7.07
3	Carpenter Bees	67	18.21
4	Honey Bees	141	38.32
	Total	368	100.00

Mangifera indica

A total of 508 visits were made by six insect groups. The most frequent flower visitors were flies (n=158) followed by honey bees (n=84), butterflies (n=31) and Carpenter bees (n=15) (Table 29).

Table 29. Insect pollinators of *Mangifera indica*

S.No	Name of Insect	No of visits	%
1	Butterflies	31	6.10
2	Flies	158	31.10
3	Carpenter Bees	15	2.95
4	Ants	208	40.94
5	Honey Bees	84	16.54
6	Beetle s	12	2.36
	Total	508	100.00

Tamarindus indica

A total of 291 visits were made by four insect groups. The most frequent flower visitors were Rock bees (n=113) followed by Carpenter bees (n=92), moths (n=69), butterflies (n=17) (Table 30).

Table 30. Insect Pollinators of *Tamarindus indica*

S.No	Name of Insect	No of visits	%
1	Butterflies	17	5.84
2	Carpenter Bees	92	31.62
3	Moths	69	23.71
4	Rock Bees	113	38.83
	Total	291	100.00

Erythroxylum monogynum

A total of 596 visits were made by four insect groups. The most frequent flower visitors were butterflies (n=301) followed by Carpenter bees (n=121) and other bees (n=102) (Table 31).

Table 31. Insect Pollinators of *Erythroxylum monogynum*

S.No	Name of Insect	No of visits	%
1	Butterflies	301	50.50
2	Rock Bees	72	12.08
3	Carpenter Bees	121	20.30
4	Other Bees	102	17.11
	Total	596	100.00

Diospyros montana

A total of 305 visits were made by two insect groups. The most frequent flower visitors were butterflies (n=213) followed by Honey bees (n=92) (Table 32).

Table 32. Insect Pollinators of *Diospyros montana*

S.No	Name of Insect	No of visits	%
1	Butterflies	213	69.84
2	Honey Bees	92	30.16
	Total	305	100.00

Tropical Dry Evergreen Forest: Point Calimere

Point Calimere

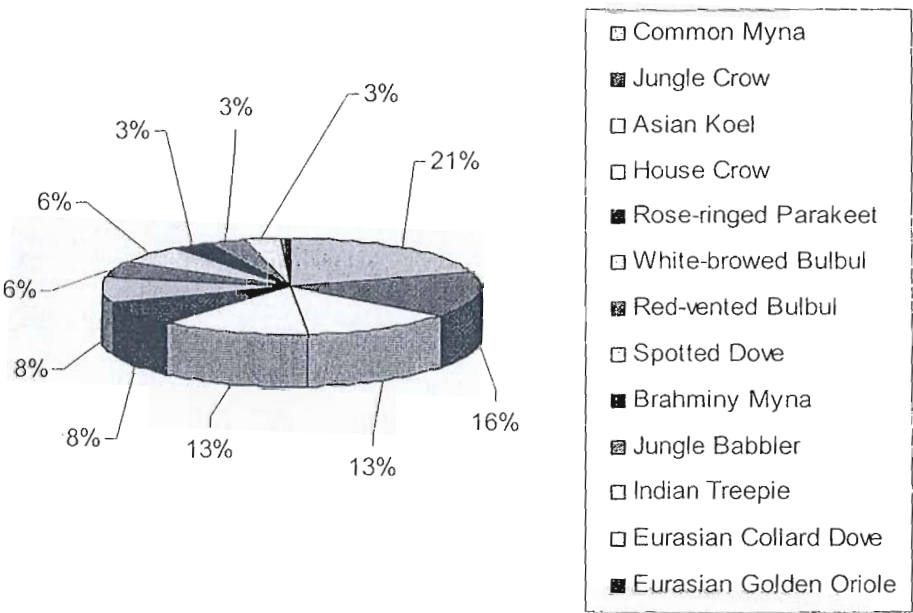
Point Calimere Wildlife Sanctuary (10°18'N; 79° 51' E) is situated at a low promontory on the Coromandel Coast in Nagapattinam district, Tamil Nadu state, India. The annual rainfall ranges from 1000-1500mm. The temperature ranges from 21°C to 35°C. Point Calimere also called Cape Calimere and Kodikkarai is a low headland on the Coromandel Coast. It is the apex of the Cauvery River delta, and marks a nearly right-angle turn in the coastline. A historic landmark here was the Chola lighthouse, destroyed in the tsunami of 2004.

The forests of Point Calimere also known the Vedaranyam forests, are one of the last remnants of the dry evergreen forests that were once typical of the East Deccan dry evergreen forests ecoregion. The Point Calimere Wildlife Sanctuary, with an area of 24.17 km², was created on June 13, 1967. The sanctuary includes three natural habitat types: dry evergreen forests, mangrove forests, and wetlands. In 1988, the sanctuary was enlarged to include the Great Vedaranyam Swamp and the Talaignayar Reserve Forest, and renamed the Point Calimere Wildlife and Bird Sanctuary, with a total area of 377 km².

Fruit eating birds in the Tropical dry evergreen forest of Point Calimere

A total of 11 plant species were observed for recording the frugivorous birds. In total 3385 individuals belonging to 13 species of frugivorous bird species were recorded. Major frugivores included Common Myna (n=661) followed by Jungle Crow (n=487) and Asian Koel (n=440). Common Myna visited 11 species and Jungle Crow visited 4 plant species (Fig. 53).

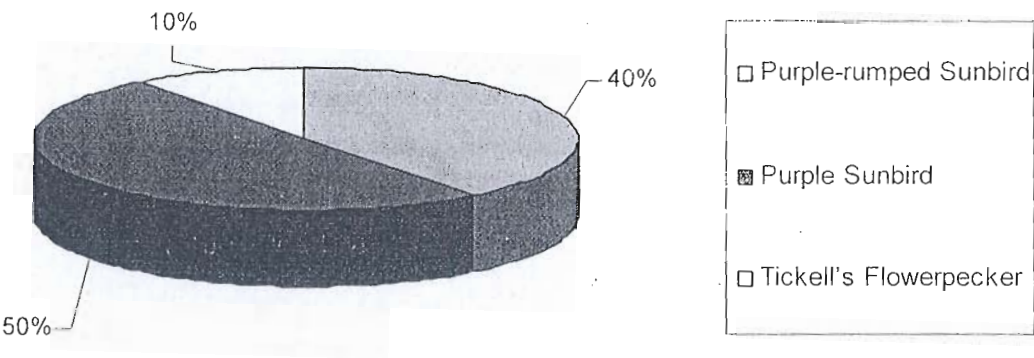
Fig. 53 Frugivores in the tropical dry evergreen forest



Nectar feeding birds observed in the Tropical dry evergreen forest

Three plant species were observed for recording the nectarivorous birds. A total of 562 individuals belonging to 3 species of nectarivorous birds visited the flowers. Maximum number of visits were made by Purple Sunbird (50.18%) followed by Purple-rumped Sunbird (39.50%) and Tickell's Flowerpecker (10.32%) (Fig. 54). Purple Sunbird and Purple-rumped sunbirds appear to be the major avian pollinators in the tropical dry evergreen forest.

Fig. 54 Nectarivorous birds in the tropical dry evergreen forest

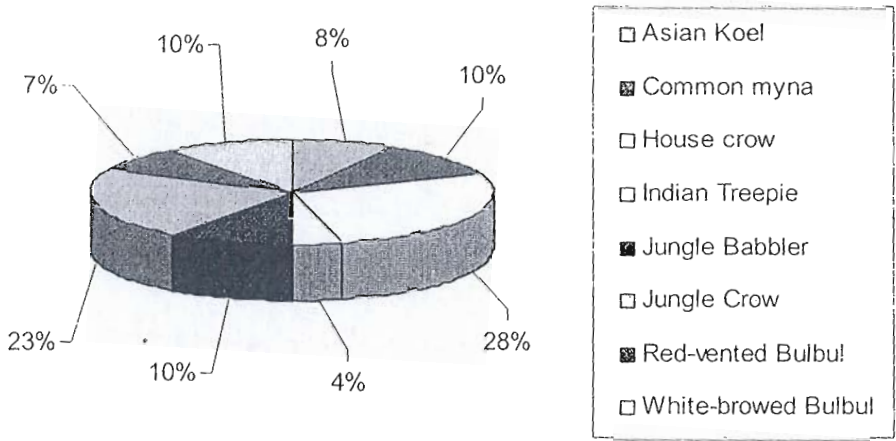


Fruit eating birds of various plant species

Ficus microcarpa

A total of 461 visits were made by 7 species of nectarivorous birds. Among them maximum number of individuals were represented by House crow (27.33%) followed by Jungle Crow (22.13%) and Common Myna (10.41%), and White-browed Bulbul (10.41%) (Fig. 55).

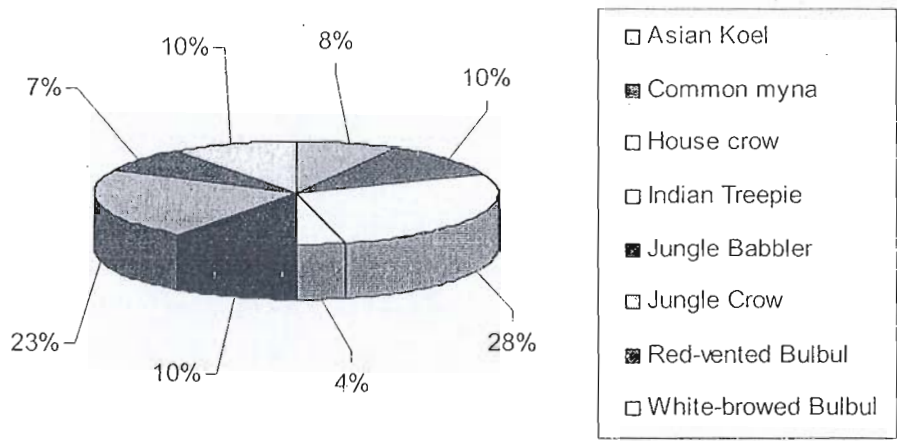
Fig. 55. Frugivore visitation to *Ficus microcarpa*



Canthium dicoccum

A total of 344 visits were made by 6 species frugivorous birds. Maximum number of frugivorous birds observed include Common Myna (43.60%) followed by Asian Koel (18.31%) and Brahminy Starling (11.05%) (Fig. 56).

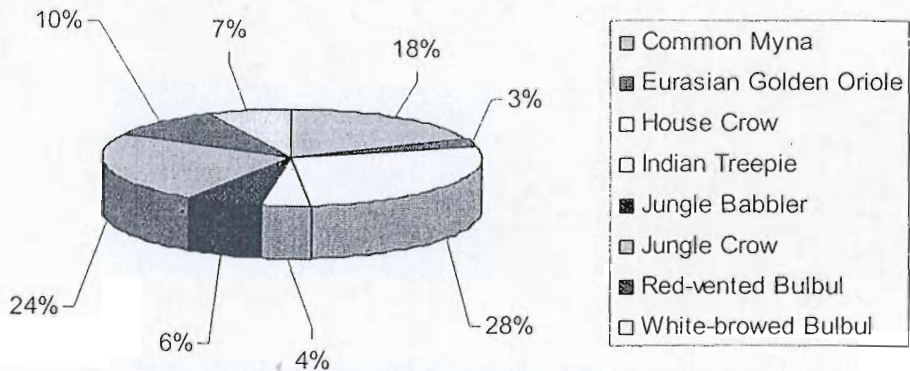
Fig. 56. Frugivore visitation to *Canthium dicoccum*



Ficus benghalensis

A total of 447 visits were made by eight species of frugivorous birds. Maximum number of maximum number of visits was made by House Crow (26.85%) followed by Jungle Crow (23.71%) and Common Myna (18.34%) (Fig. 57).

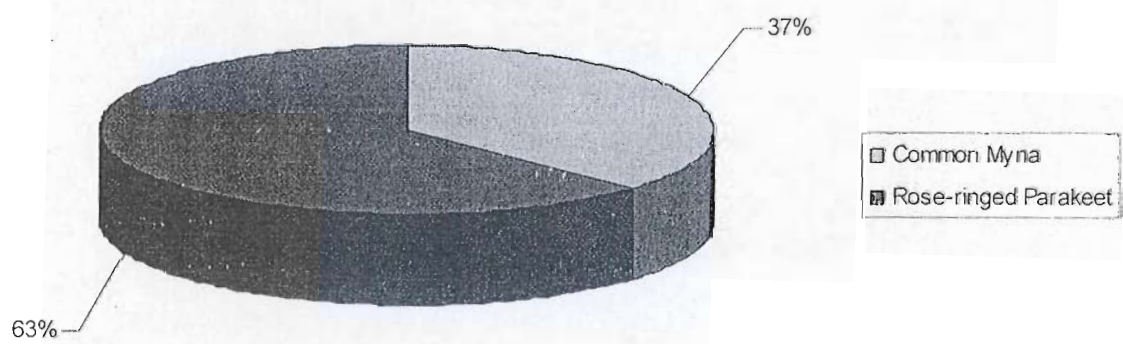
Fig. 57 Frugivore visitation to *Ficus benghalensis*



Drypetes sepiaria

A total of 192 visits was made by two species of frugivorous birds. Maximum number of visits was made by Rose-ringed Parakeet (63.02%) followed by Common Myna (36.98%) (Fig. 58).

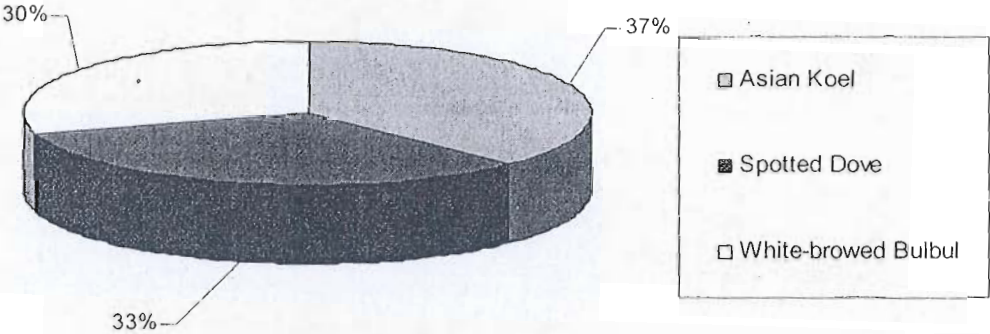
Fig. 58 Frugivore visitation to *Drypetes sepiaria*



Māba buxifolia

A total of 353 visits were made by 3 species of frugivorous birds. Maximum number of visits were made by Asian Koel (37.39%) followed by Spotted Dove (32.86%) and White-browed Bulbul (29.75%) (Fig. 59).

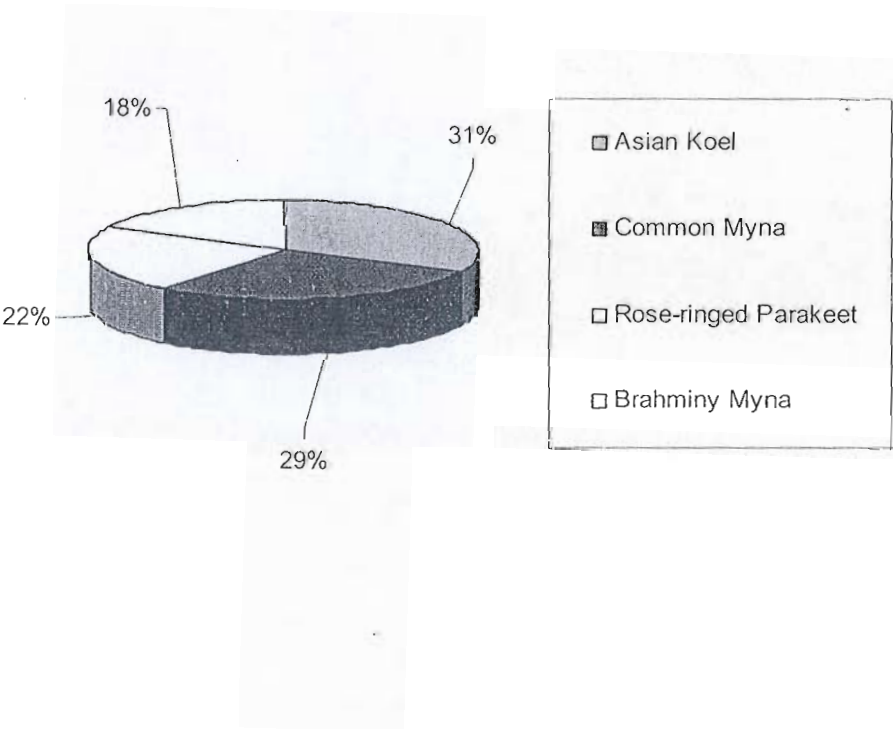
Fig. 59. Frugivore visitation to *Maba buxifolia*



Zizyphus oenoplia

A total of 221 visits were made by 4 species of frugivores. Maximum number of visits were made by Asian Koel (32.13%) followed by Common Myna (28.51%) and Rose-ringed Parakeet (21.72%) (Fig. 60).

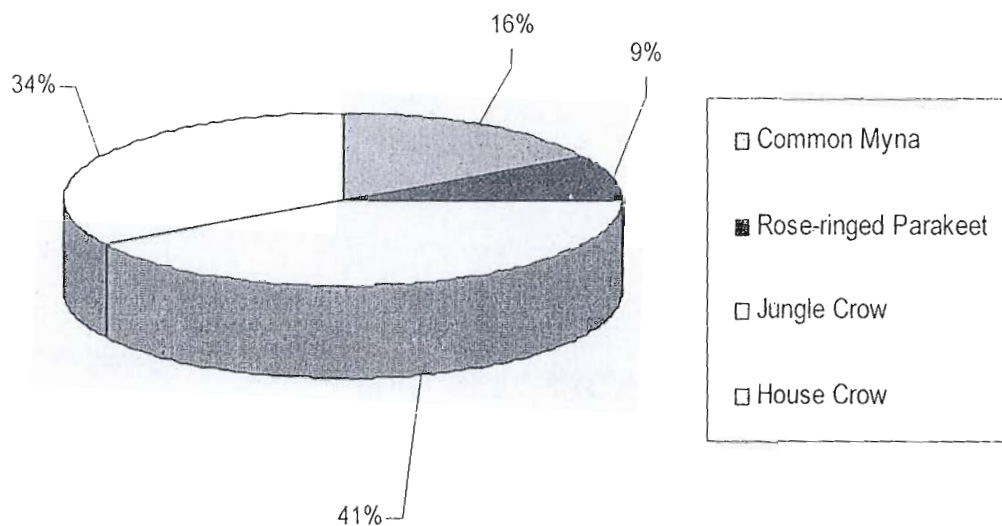
Fig. 60. Frugivore visitation to *Zizyphus oenoplia*



Salvadora persica

A total of 502 visits were made by four species of frugivorous birds. Most frequently visited birds include Jungle Crow (40.84%) followed by House Crow (33.86%) and Common Myna (16.33%) (Fig 61).

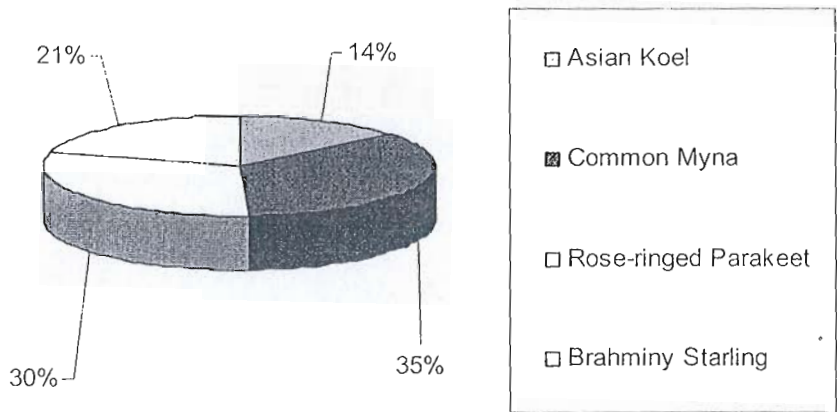
Fig. 61. Frugivore visitation to *Salvadora persica*



Randia malabarica

A total of 71 visits were made by 4 species of frugivorous birds. Most frequently visited birds include Common Myna (35.21%) followed by Rose-ringed Parakeet (29.58%) and Brahminy Starling (21.13%) (Fig. 62).

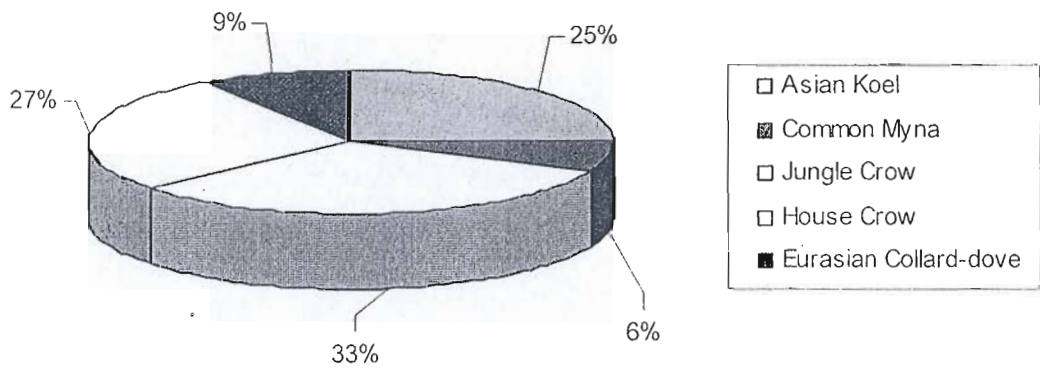
Fig. 62. Frugivore visitation to *Randia malabarica*



Ehretia ovalifolia

A total of 231 visits were made by 5 species of frugivorous birds. Most frequently visited birds include Junlge Crow (32.03%) followed by House Crow (27.27%) and Asian Koel (25.11%) (Fig. 63).

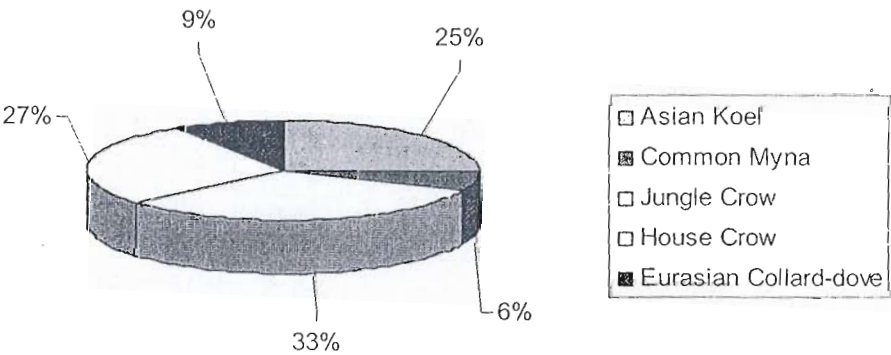
Fig. 63. Frugivore visitation to *Ehretia ovalifolia*



Memecylon umbellatum

A total of 141 visits were made by 5 species of frugivorous birds. Most frequently visited birds include Asian Koel (32.03%%) followed by Spotted Dove (27.27%) and Common Myna (25.11%) (Fig. 64).

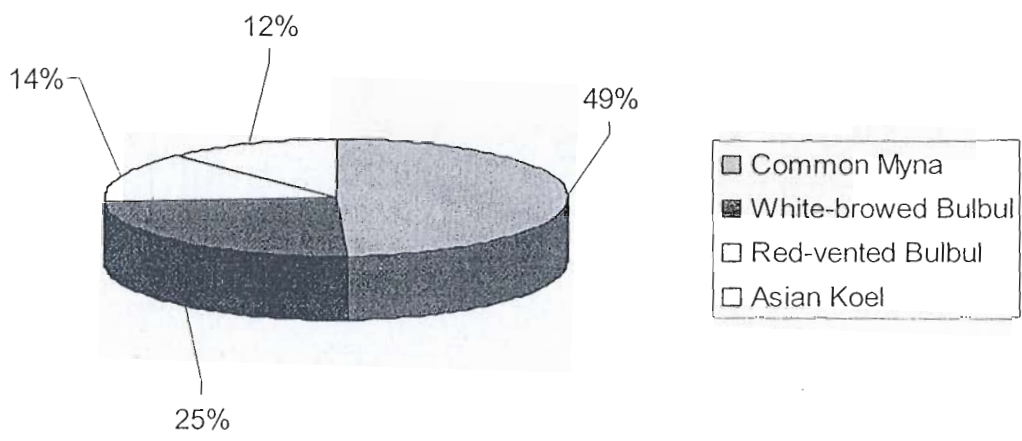
Fig. 64. Frugivore visitation to *Memecylon umbelatum*



Syzygium cumini

A total of 65 visits were made by 4 species of frugivorous birds. Most frequently visited birds include Common Myna (n=32) (49.23%) followed by White-browed Bulbul (24.62%) and Red-vented Bulbul (13.85%) (Fig. 65).

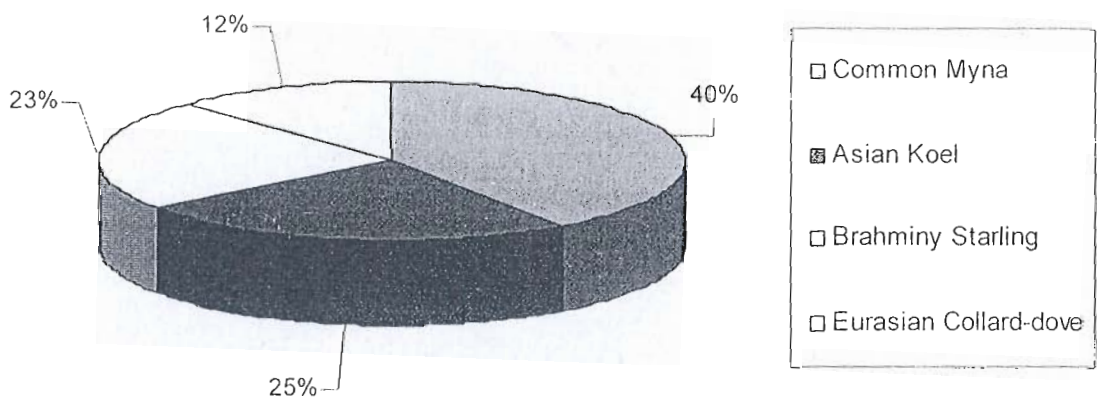
Fig. 65 Frugivore visitation to *Syzygium cumini*



Carissa spinarum

A total of 122 visits were made by 4 species of frugivorous birds. Most frequently visited birds include Common Myna (40.16%) followed by Asian Koel (24.59%) and Brahminy Starling (22.95%) (Fig. 66).

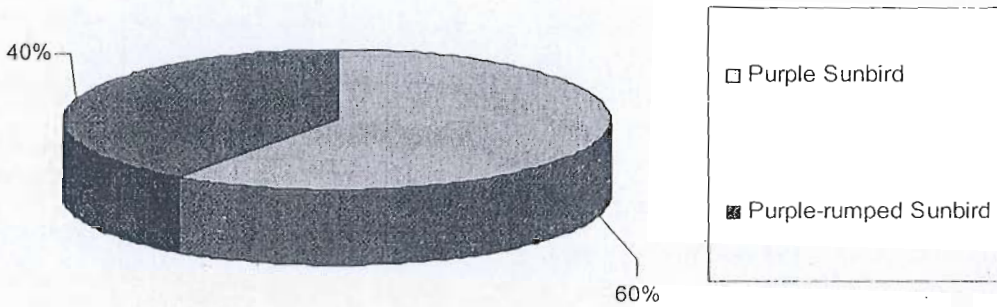
Fig. 66. Frugivore visitation to *Carissa spinarum*



Nectarivorous birds observed on *Walsura trifolia*

A total of 127 visits were made by 2 species of nectarivorous birds. Maximum number of visits were made by Purple Sunbird (59.84%) followed by Purple-rumped Sunbird (40.16%) (Fig. 67).

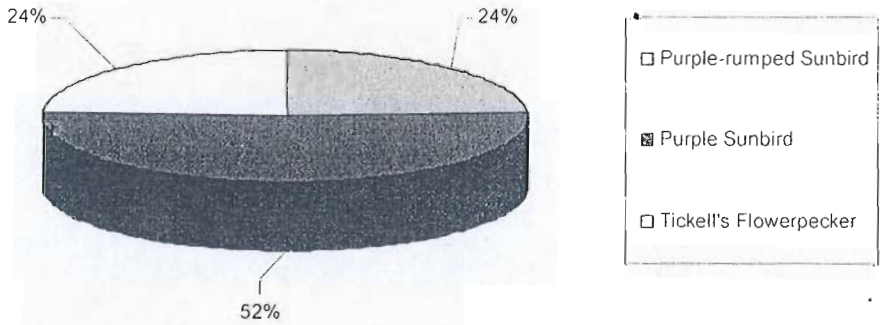
Fig. 67 Nectarivores observed at *Walsura trifolia*



Syzygium cumini

A total of 241 visits were made by 3 species of nectarivorous birds. Maximum number of visits was made by Purple Sunbird (51.87%) followed by Purple-rumped Sunbird (24.07), Tickell's Flowerpecker (24.07%) (Fig. 68).

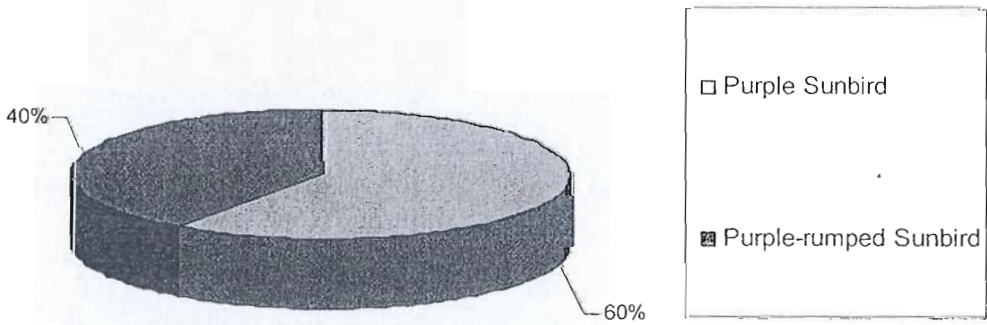
Fig. 68. Nectarivores observed at *Syzygium cumini*



Ochna obtusata

A total of 120 visits were made by 2 species of nectarivorous birds. Maximum number of visits were made by Purple Sunbird (67.50%) followed by Purple-rumped Sunbird (32.50%) (Fig. 69).

Fig. 69. Nectarivores observed at *Ochna obtusata*



Insect Pollinators

Insect visitors to various plant species in the Tropical dry evergreen forest (TDEF)

A total of 5610 individuals belonging to 7 groups of insect pollinators were recorded in the tropical dry evergreen forest of Point Calimere (Table 34). Most frequently visited insect pollinators include butterflies (28.25%) followed by honey bees (26.01%) and bees (19.98%). *Syzygium cumini* attracted a largest number of insects (n=2208).

Table 34. Insect visitors observed at various plant species in TDEF

S.No	Insect group	M.H	C.F	W.T	A.M	P.D	C.D	O.O	R.M	S.C	M.E	No. of visits	%
1	Butterflies	183	75	244	288	251	152	126	224	-	42	1585	28.25
2	Honey Bees	78	17	160		84	372	288	-	460	-	1459	26.01
3	Carpenter Bees	138	50	60	43	70	40	52	24	-	96	573	10.21
4	Ants	62	-	-	68	-	-	-	-	118	-	248	4.42
5	Wasps	24	13	-	-	-	-	-	-	188	-	225	4.01
6	Flies	36	-	-	-	-	-	-	-	321	42	399	7.11
7	Beetles	-	-	-	-	-	-	-	-	1121	-	1121	19.98
	Total	521	155	464	399	405	564	466	248	2208	180	5610	100.00

A.M = *Atalantia monophylla*, *P.D* = *Pithcellobium dulce*, *C.D* = *Canthium dicoccum*,
O.O = *Ochna obtusata*, *R.M* = *Randia malabarica*, *S.C* = *Syzygium cumini*,
M.H = *Manilkara hexandra*, *C.F* = *Cassia fistula*, *W.T* = *Walsura trifolia*,
M.E = *Mimusops elengi*

Butterfly attracting plants in the Tropical Dry evergreen Forest

A total of 1605 individuals belonging to 13 species of lepidopteron visitors were attracted by 9 plant species in the tropical dry evergreen forest of Point calimere (Table 35). Maximum number of insects were attracted by *Atlantia monophylla* (n=288) followed by *Walsura trifolia* (n=244) and *Randia malabarica* (n=224).

Table 35 Butterfly visitors to various plant species in the Tropical dry evergreen forest

S.No	Name of the Plant	Cr.R	P.T	T.C	C.E	C.R	C.M	C.G	B.T	C.L	S.T	D.C	G.E.F	Y.O.T	No. of visits	%
1	<i>Manilkara hexandra</i>	30	-	-	-	-	16	32	-	84	-	-	21	-	183	11.40
2	<i>Cassia fistula</i>	11	20	8	15	21	-	-	-	-	-	-	-	-	75	4.67
3	<i>Walsura trifolia</i>	-	52	-	-	-	48	102	42	-	-	-	-	-	244	15.20
4	<i>Atlantia monophylla</i>	-	44	-	44	-	37	20	117	-	-	26	-	-	288	17.94
5	<i>Pithecellobium dulce</i>	65	88	-	-	-	-	-	-	-	16	102	-	-	271	16.88
6	<i>Canthium dicoccum</i>	82	-	-	-	-	-	-	70	-	-	-	-	-	152	9.47
7	<i>Ochna obtusata</i>	-	-	-	-	-	52	74	-	-	-	-	-	-	126	7.85
8	<i>Randia malabarica</i>	30	-	-	-	-	50	-	-	-	-	45	40	59	224	13.96
9	<i>Mimusops elengi</i>	-	-	-	-	-	42	-	-	-	-	-	-	-	42	2.62
	Total	218	204	8	59	21	245	228	229	84	16	173	61	59	1605	100.00

C.L = Common Leopard, S.T = Striped Tiger, D.C = Dark Cloudy, G.E.F = Great Egg Fly, Y.O.T=Yellow Orange Tip

Cr.R = Crimson Rose, P.T = Plain Tiger, T.C = Tawny Coster, C.E = Common Emigrant,

C.R = Common Rose, C.M = Common Mormon, C.G = Common Gull, B.T= Blue Tige,

HYMENOPTERAN ATTRACTING PLANTS IN THE TROPICAL DRY EVERGREEN FOREST

A total of 2453 visits were made by 6 hymenopteran species on 10 plant species. *Syzygium cumini* (n=714) followed by *Canthium dicoccum* (n=412) and *Ochna obtusata* (n=340) formed the major hymenopteran attracting plants (Table 36).

Table 36 Hymenopteran visitors to various plant species in Point Calimere

S.No	Name of Plant	C.B	An	A.I	R.B	W	No. of visits	%
1	<i>Manilkara hexandra</i>	138	62	78	-	24	302	12.31
2	<i>Cassia fistula</i>	50	-	17	-	13	80	3.26
3	<i>Walsura trifolia</i>	60	-	160	-	-	220	8.97
4	<i>Atalantia monophylla</i>	43	68	-	-	-	111	4.53
5	<i>Pithecellobium dulce</i>	70	-	84	-	-	154	6.28
6	<i>Canthium dicoccum</i>	40	-	182	190	-	412	16.80
7	<i>Ochna obtusata</i>	52	-	124	164	-	340	13.86
8	<i>Randia malabricam</i>	24	-	-	-	-	24	0.98
9	<i>Syzygium cumini</i>	-	89	-	436	189	714	29.11
10	<i>Mimusops elengi</i>	96	-	-	-	-	96	3.91
	Total	573	219	645	790	226	2453	100.00

C.B = Carpenter Bee, An = Ants, A.I = *Apis indica*, R.B = Rock Bee, W = Wasp,
A.D=*Apis dorsata*

INSECT POLLINATORS OF DIFFERENT PLANT SPECIES

Manilkara hexandra

A total of 521 visits were made by 6 insect groups. Most frequent flower visitors were butterflies (n=183) followed by Carpenter bees (n=138) and honey bees (n=78) (Table 37).

Table 37. Insect Pollinators of *Manilkara hexandra*

S.No	Name of Insect	No. of visits	%
1	Butterflies	183	35.12
2	Carpenter Bees	138	26.49
3	Ants	62	11.90
4	Honey Bees	78	14.97
5	Wasps	24	4.61
6	Flies	36	6.91
	Total	521	100.00

Cassia fistula

A total of 145 visits were made by 4 insect groups. Most frequent flower visitors were butterflies (n=65) followed by Carpenter Bees (n=50) honey Bees (n=17) (Table 38).

Table 38 Insect Pollinators of *Cassia fistula*

S.No	Name of Insect	No. of visits	%
1	Butterflies	65	44.83
2	Carpenter Bees	50	34.48
3	Wasps	13	8.97
4	Honey Bees	17	11.72
	Total	145	100.00

Walsura trifolia

A total of 464 visits were made by 3 insect groups. Most frequent flower visitors were butterflies (n=244) followed by honey Bees (n=160) and Carpenter Bees (n=60) (Table 39).

Table 39. Insect Pollinators of *Walsura trifolia*

S.No	Name of Insect	No. of visits	%
1	Butterflies	244	52.59
2	Carpenter Bees	60	12.93
3	Honey Bees	160	34.48
	Total	464	100.00

Atalantia monophylla

A total of 399 visits were made by 3 insect groups. Most frequent flower visitors were butterflies (n=288) followed by Carpenter Bees (n=43) (Table 40).

Table 40. Insect Pollinators of *Atalantia monophylla*

S.No	Name of Insect	No. of visitors	%
1	Butterflies	288	72.18
2	Carpenter Bees	43	10.78
3	Ants	68	17.04
	Total	399	100.00

Pithecollobium dulce

A total of 405 visits were made by 3 insect groups. Most frequent flower visitors were butterflies (n=251) followed by honey bees (n=84), Carpenter Bees (n=70) (Table 41).

Table 41. Insect Pollinators of *Pithecollobium dulce*

S.No	Name of Insect	No. of visits	%
1	Butterflies	251	61.98
2	Carpenter Bees	70	17.28
3	Honey Bees	84	20.74
	Total	405	100.00

Canthium dicoccum

A total of 564 visits were made by 3 insect groups. Most frequent flower visitors were honey bees (n=372) followed by butterflies (n=152) and Carpenter Bees (n=40) (Table 42).

Table 42. Insect pollinators of *Canthium dicoccum*

S.No	Name of Insect	No. of visits	%
1	Butterflies	152	26.95
2	Carpenter Bees	40	7.09
3	Honey Bees	372	65.96
	Total	564	100.00

Ochna obtusata

A total of 466 visits were made by 3 insect groups. Most frequent flower visitors were honey bees (n=288) followed by butterflies (n=126) and Carpenter Bees (n=52) (Table 43).

Table 43. Insect pollinators of *Ochna obtusata*

S.No	Name of Insect	No. of visits	%
1	Butterflies	126	27.04
2	Carpenter Bees	52	11.16
3	Honey Bees	288	61.80
	Total	466	100.00

Randia malabrica

A total of 248 visits were made by 2 insect groups. Most frequent flower visitors were butterflies (n=224) followed by Carpenter Bees (n=24) (Table 44).

Table 44 Insect Pollinators of *Randia malabrica*

S.No	Name of Insect	No. of visits	%
1	Butterflies	224	90.32
2	Carpenter Bees	24	9.68
	Total	248	100.00

Syzygium cumini

A total of 2208 visits were made by 5 insect groups. Most frequent flower visitors were beetles (n=1121) followed by Rock bees (n=460) and wasps (n=188) (Table 45).

Table 45 Insect Pollinators of *Syzygium cumini*

S.No	Name of Insect	No. of visits	%
1	Rock Bees	460	20.83
2	Wasps	188	8.51
3	Beetles	1121	50.77
4	Flies	321	14.54
5	Ants	118	5.34
	Total	2208	100.00

Mimusops elengi

A total of 180 visits were made by 3 insect groups. Most frequent flower visitors were Carpenter bees (n=96) followed by butterflies (n=42) and flies (n=42) (Table 46).

Table 46. Insect Pollinators of *Mimusops elengi*

S.No	Name of Insect	No. of visits	%
1	Butterflies	42	23.33
2	Carpenter Bees	96	53.33
3	Flies	42	23.33
	Total	180	100.00

Kanchipuram/Chengalpet/Chennai :Scrub Forest

Study area

Kancheepuram district is situated on the East Coast of Tamil Nadu adjacent to Chennai city and is bounded in the west by Vellore and Thiruvannamalai district, in the north by Thiruvallur district and Chennai district, in the south by Villuppuram district in the east by Bay of Bengal. It lies between $11^{\circ} 00'$ to $12^{\circ} 00'$ North latitudes and $77^{\circ} 28'$ to $78^{\circ} 50'$ East longitudes. The district has a total geographical area of 4, 43,210 hectares and coastline of 57 Km. There are only a few hills of considerable elevation in the district. The southern part of Maduranthakam taluk contains small hills. The total forest area in the district is 23,586 hectares, out of which 366.675 hectares is Reserved Land.

The pre-monsoon rainfall is almost uniform throughout the district. The coastal regions receive more rainfall than the interior ones. The district is mainly dependent on the monsoon rains. Northeast and Southwest monsoon are the major donors, with 54% and 36% contribution each to the total annual rainfall. During normal monsoon year, the district receives a rainfall of 1200 mm. Palar is the most important river running through the district.

Fruit eating birds observed in the scrub forests

A total of ten fleshy fruited tree species was observed to record the fruit eating birds in the scrub forest. A total of 3294 visits were made by 11 frugivorous bird species (Table 47). Most frequent frugivorous visitors were Common Myna (n=1083) followed by House Crow (n=693) and Red-vented Bulbul (n=395). *Ficus religiosa* (n=1094) attracted maximum number of birds, followed by *Ficus benghalensis* (n=512). Maximum number of frugivorous bird species were recorded at *Ficus religiosa*, *Syzygium cumini* (n=7) followed by *Pithecellobium dulce*, *Ficus benghalensis* (n=7). Common Myna, House Crow, Red-vented Bulbul visited maximum number of tree species in the study area and appear to be major seed dispersers.

Table 47 Fruit eating birds observed at various plant species in the scrub forests

S.No	Bird Name	Plant name										Bird visits	
		Z.O	F.I	F.B	P.D	M.A	F.R	A.I	L.C	S.C	M.B	#	%
1	Common Myna	38	110	187	148	24	267	52	78	96	83	1083	32.88
2	House Crow	19	15	154	112	22	233	46	65	26	1	693	21.04
3	Red-vented Bulbul	40	56	45	87	21	68	8	32	26	12	395	11.99
4	Coppersmith Barbet	-	-	43	43	-	198	-	-	12	-	296	8.99
5	Indian Treepie	-	-	41	22	18	127	-	-	11	-	219	6.65
6	Rose-ringed Parakeet	-	-	-	-	-	156	-	-	-	-	156	4.74
7	Eurasian Golden Oriole	-	-	42	37	-	45	-	28	16	-	168	5.10
8	White headed Babbler	50	98	-	-	-	-	-	-	-	-	148	4.49
9	White-browed Bulbul	-	1	-	-	-	-	-	89	-	-	90	2.73
10	Asian Koel	5	-	-	-	-	-	17	-	15	-	37	1.12
11	Jungle babbler	9	-	-	-	-	-	-	-	-	-	9	0.27
		161	280	512	449	85	1094	123	292	202	96	3294	100.00

Z.O= *Zizyphus oenoplia*, F.I= *Flacourtia indica*, F.B= *Ficus benghalensis*,
P.D= *Pithecellobium dulce*, M.A= *Melia azedarach*, F.R= *Ficus religiosa*, A.I=
Azadirachta indica, L.C= *Lannea coromandelica*, S.C= *Syzygium cumini*, M.B=
Maba buxifolia

Important bird attracting trees in scrub forests

A total of 10 tree species were observed for recorded the frugivorous bird species in the scrub forest. Majority of the frugivores were attracted by *Ficus religiosa* (n=1094) and *Ficus benghalensis* (n=512) (Table 48). *Ficus* species are appear to be the major bird attracting plants in the scrub forests.

Table 48 Major bird attracting trees in scrub forests

S.No	Plant species	No. Of bird visits	%
1	<i>Ficus religiosa</i>	1094	33.21
2	<i>Ficus benghalensis</i>	512	15.54
3	<i>Pithecellobium dulce</i>	449	13.63
4	<i>Lannea coromandelica</i>	292	8.86
5	<i>Flacourtia indica</i>	280	8.50
6	<i>Syzygium cumini</i>	202	6.13
7	<i>Zizyphus oenoplia</i>	161	4.89
8	<i>Azadirachta indica</i>	123	3.73
9	<i>Maba buxifolia</i>	96	2.91
10	<i>Melia azedarach</i>	85	2.58
		3294	100.00

Zizyphus oenoplia

A total of 161 visits were made by 6 species of frugivorous birds. Most frequently visited birds include White-headed Babbler (n=50) followed by Red-vented Bulbul (n=40) and Common Myna (n=38) (Table 49).

Table 49. Frugivores observed at *Zizyphus oenoplia*

S.No	Bird species	No. of visits	%
1	White-headed Babbler	50	31.06
2	Red-vented Bulbul	40	24.84
3	Common Myna	38	23.60
4	House Crow	19	11.80
5	Jungle Babbler	9	5.59
6	Asian Koel	5	3.11
		161	100.00

Flacourtia indica

A total of 280 visits were made by 5 species of frugivorous birds. Most frequently visited birds include Common Myna (n=110) followed by White-headed Babbler (n=98) and Red-vented Bulbul (n=56) (Table 50).

Table 50 Frugivores observed at *Flacourtia indica*

S.No	Bird species	# of visits	%
1	Common Myna	110	39.29
2	White-headed Babbler	98	35.00
3	Red-vented Bulbul	56	20.00
4	House Crow	15	5.36
5	Asian Koel	1	0.36
		280	100.00

Ficus benghalensis

A total of 512 visits were made by 6 species of frugivorous birds. Most frequently visited birds include Common Myna (n=187) followed By House Crow (m=154) and Red-vented Bulbul (n=45) (Table 51).

Table 51 Frugivores observed at *Ficus benghalensis*

S.No	Bird species	# of visits	%
1	Common Myna	187	36.52
2	House Crow	154	30.08
3	Red-vented Bulbul	45	8.79
4	Copper-smith Barbet	43	8.40
5	Indian Treepie	41	8.01
6	Eurasian Golden Oriole	42	8.20
		512	100.00

Pithecellobium dulce

A total of 449 visits were made by 6 species of frugivorous birds. Most frequently visited frugivores observed include Common Myna (n=148) followed by House Crow (n=112) and Red-vented Bulbul (n=87) (Table 52).

Table 52 Frugivores observed at *Pithecellobium dulce*

S.No	Bird species	# of visits	%
1	Common Myna	148	32.96
2	House Crow	112	24.94
3	Red-vented Bulbul	87	19.38
4	Copper-smith Barbet	43	9.58
5	Indian Treepie	22	4.90
6	Eurasian Golden Oriole	37	8.24
		449	100.00

Melia azedarach

A total of 85 visits were made by 4 species of of frugivorous birds. Most frequent visitors include Common Myna (n=24) followed by House Crow (n=22) and Red-vented Bulbul (n=21) (Table 53).

Table 53 Frugivores observed at *Melia azedarach*

S.No	Bird species	# of visits	%
1	Common Myna	24	28.24
2	House Crow	22	25.88
3	Red-vented Bulbul	21	24.71
4	Indian Treepie	18	21.18
		85	100.00

Ficus religiosa

A total of 1094 visits was made by 7 species of frugivorous birds. Most frequent visitors include Common Myna (n=267) followed by House Crow (n=233) and Copper-smith Barbet (n=198) (Table 54).

Table 54 Frugivores observed at *Ficus religiosa*

S.No	Bird species	# of visits	%
1	Common Myna	267	24.41
2	House Crow	233	21.30
3	Coppersmith Barbet	198	18.10
4	Rose-ringed Parakeet	156	14.26
5	Indian Treepie	127	11.61
6	Red-vented Bulbul	68	6.22
7	Eurasian Golden Oriole	45	4.11
		1094	100.00

Azadirachta indica

A total of 123 visits were made by 4 species of frugivorous birds. Most frequent visitors include Common Myna (n=52) followed by House Crow (n=46) and Red-vented Bulbul (n=17) (Table 55).

Table 55. Frugivores observed at *Azadirachta indica*

S.No	Bird species	# of visits	%
1	Common Myna	52	42.28
2	House Crow	46	37.40
3	Red-vented Bulbul	8	6.50
4	Asian Koel	17	13.82
		123	100.00

Lannea coromandelica

A total of 292 visits were made by 5 species of frugivorous birds. Most frequent visitors include White-browed Bulbul (n=89) followed by Common Myna (n=78) and House Crow (n=65) (Table 56).

Table 56 Frugivores observed at *Lannea coromandelica*

S.No	Bird species	# of visits	%
1	White-browed Bulbul	89	30.48
2	Common Myna	78	26.71
3	House Crow	65	22.26
4	Red-vented Bulbul	32	10.96
5	Eurasian Golden Oriole	28	9.59
		292	100.00

Syzygium cumini

A total of 202 visits was made by 7 species of frugivorous birds. Most frequent visitors include Common Myna (n=96) followed by House Crow (n=26), Red-vented Bulbul (n=26) (Table 57).

Table 57. Frugivores observed at *Syzygium cumini*

S.No	Bird species	# of visits	%
1	Common Myna	96	47.52
2	House Crow	26	12.87
3	Red-vented Bulbul	26	12.87
4	Eurasian Golden Oriole	16	7.92
5	Asian Koel	15	7.43
6	Coppersmith Barbet	12	5.94
7	Indian Treepie	11	5.45
		202	

Maba buxifolia

A total of 96 visits was made by 3 species of frugivorous birds. Most frequent visitors include Common Myna (n=83) followed by Red-vented Bulbul (n=12) and House Crow (n=1) (Table 58).

Table 58 Frugivores observed at *Maba buxifolia*

S.No	Bird species	# of visits	%
1	Common Myna	83	86.46
2	Red-vented Bulbul	12	12.50
3	House Crow	1	1.04
		96	100.00

Mangrove forests of Muthupet

Muthupet is situated 400 km south of Chennai and lies close to Point Calimere on the Southeast coast of Peninsular India. It is at the southern end of the Cauveri delta covering an area of approximately 6800 ha of which only 4% is occupied by well-grown mangroves. Various tributaries of the river Cauveri flow through Muthupet and adjacent villages. At the tail end, they form a lagoon before meeting the Palk Strait. The northern and western borders of the lagoon are occupied by a sand spit which is devoid of mangrove vegetation. This mangrove forest was declared as Reserve Forest in February 1937 by the Government of Tamil Nadu (Shanmugasundaram, 1985). Muthupet's wetlands are associated with the coastal wet lands of Vedaranyam. This mangrove forest attracts seasonal migratory birds such as flamingos from far off countries such as Siberia, Australia, Russia and Europe in the monsoon season.

Nectar feeding birds in the Mangrove Forest

Avicennia marina

A total of 73 visits were made by 2 bird species, namely Purple Sunbird (62%) followed by Purple-rumped Sunbird (38%). These two birds appear to be the major nectarivores in the mangrove forest.

Table 59. Flower visitors observed on *A. marina*

S.No	Bird species	A.M	%
1	Purple-rumped Sunbird	28	38.36
2	Purple Sunbird	45	61.64
		73	100.00

INSECT POLLINATORS IN THE MANGROVE FORESTS OF MUTHUPET

A total of 1703 visits were made by 5 groups of insect pollinators (Table 60). Majority of the flower visitors were attracted by *Avicennia marina* (n=760). Important insect pollinators appear to be ants.

Table 60. Insect visitors observed at various plant species in the mangrove forests

S.No	Insect Name	A.I	A.M	R.M	A.C	# of visits	%
1	Butterflies	-	32	-	-	32	1.88
2	Carpenter Bees	-	145	-	-	145	8.51
3	Wasps	52	137	56	-	245	14.39
4	Beetles		66	-	-	66	3.88
5	Ants	217	380	303	315	1215	71.34
	Total	269	760	359	315	1703	100.00

A.I=*Acanthus ilicifolius*, *A.M*= *Avicennia marina*, *R.M*= *Rhizophora mucronata*
A.C=*Aegiceras corniculatum*

Insect pollinators in the Mangrove Forest of Muthupet

Acanthus ilicifolius

A total of 269 visits were made by 2 groups of insects. Most frequent flower visitors were ants (n=217) and wasps (n=52).

Avicennia marina

A total of 380 visits were made by 4 insect groups. Most frequent flower visitors were Carpenter bees (n=145) followed by wasps (n=137) and beetles (n=66) (Table 61).

Table 61. Insect Pollinators of *Avicennia marina*

S.No	Name of Insect	# of visits	%
1	Wasps	137	36.05
2	Beetles	66	17.37
3	Carpenter Bees	145	38.16
4	Butterflies	32	8.42
	Total	380	100.00

Rhizophora mucronata

A total of 359 visits were made by 2 insect groups. Most frequent flower visitors were ants (n=303) and wasps (n=56).

Aegiceras corniculatum

A total of 315 visits were made by ants.

Recommendations

Plants that provide food (nectar and fruits) for birds are given below. While the insects and birds that feed on flower nectar form the pollinators, birds that consume fruits form seed dispersers. Species that attract pollinators and seed dispersers are listed in Tables (62, 63, 64, 65) and are suggested for planting in the respective forest types of the state.

Table 62. Species suggested for planting in degraded Shola forests

S.No	Plant species	Family	Food source	
			Nectar	Fruit
1	<i>Daphniphyllum neilgherrense</i>	Euphorbiaceae	-	√
2	<i>Symplocos cochinchinensis</i>	Symplocaceae	√	√
3	<i>Isonandra perrottetiana</i>	Sapotaceae	√	√
4	<i>Ligustrum perrottetii</i>	Oleaceae	√	√
5	<i>Microtropis densiflora</i>	Celastraceae	√	√
6	<i>Celtis timorensis</i>	Ulmaceae	-	√
7	<i>Glochidion neilgherrense</i>	Euphorbiaceae	√	√
8	<i>Syzygium tamilnadensis</i>	Myrtaceae	√	√
9	<i>Elaeocarpus munronii</i>	Elaeocarpaceae	-	√
10	<i>Syzygium densiflorum</i>	Myrtaceae	√	√
11	<i>Ilex wightiana</i>	Aquifoliaceae	-	√
12	<i>Celtis tetrandra</i>	Ulmaceae	-	√
13	<i>Ixora notoniana</i>	Rubiaceae	√	√
14	<i>Phoebe lanceolata</i>	Lauraceae	-	√
15	<i>Euodia lunu-ankenda</i>	Rutaceae	√	√
16	<i>Turpinia nepalensis</i>	Staphyleaceae	√	√
17	<i>Litsea withtiana</i>	Lauraceae	-	√
18	<i>Michelia nilagirica</i>	Magnoliaceae	-	√
19	<i>Elaeocarpus oblongus</i>	Elaeocarpaceae	-	√
20	<i>Symplocos foliosa</i>	Symplocaceae	-	√
21	<i>Michelia champaca</i>	Magnoliaceae	-	√
22	<i>Memecylon malabaricum</i>	Melastomataceae	-	√
23	<i>Nothapodytes nimmoniana</i>	Icacinaceae	-	√
24	<i>Euonymous crenulatus</i>	Celastraceae	-	√

25	<i>Schefflera racemosa</i>	Araliaceae	-	√
26	<i>Neolitsea zeylanica</i>	Lauraceae	-	√
27	<i>Neolitsea scrobiculata</i>	Lauraceae	-	√
28	<i>Vaccinium neilgherrense</i>	Vacciniaceae	-	√
29	<i>Viburnum punctatum</i>	Caprifoliaceae	-	√
30	<i>Vaccinium leschenaultii</i>	Vacciniaceae	-	√

Table 63. Species suggested for planting in degraded dry evergreen forest

S.No	Plant species	Family	Food source	
			Nectar	Fruit
1	<i>Atalantia monophylla</i>	Rutaceae	√	-
2	<i>Azadirachta indica</i>	Meliaceae	√	√
3	<i>Canthium dicoccum</i>	Rubiaceae	√	√
4	<i>Cassia fistula</i>	Fabaceae	√	-
5	<i>Drypetes sepiaria</i>	Euphorbiaceae	√	√
6	<i>Ehretia ovalifolia</i>	Cordiaceae	-	√
7	<i>Ficus bengalensis</i>	Moraceae	-	√
8	<i>Ficus virens</i>	Moraceae	-	√
9	<i>Ficus microcarpa</i>	Moraceae	-	√
10	<i>Lannea coromandelica</i>	Anacardiaceae	-	√
11	<i>Maba buxifolia</i>	Ebenaceae	-	√
12	<i>Manilkara hexandra</i>	Sapotaceae	√	√
13	<i>Mimusops elengi</i>	Sapotaceae	-	√
14	<i>Ochna obtusata</i>	Ochnaceae	√	-
15	<i>Randia malabarica</i>	Rubiaceae	√	√
16	<i>Salvadora persica</i>	Salvadoraceae	-	√
17	<i>Syzygium cumini</i>	Myrtaceae	-	√
18	<i>Walsura trifolia</i>	Meliaceae	√	√
19	<i>Zizyphus oenoplia</i>	Rhamnaceae	-	√
20	<i>Zizyphus mauritiana</i>	Rhamnaceae	-	√
21	<i>Ixora pavetta</i>	Rubiaceae	-	√

Some bird-attracting plants in sholas



Rubus fairholmianus



Nothapodytes nimmoniana



Gaultheria frgrantissima



Michelia nilagirica



Litsea floribunda

Table 64. Species suggested for planting in the degraded sites of the dry deciduous forest, Pachamalai hills

S.No	Plant Name	Family	Food source for birds	
			Nectar	Fruit
1	<i>Albizia amara</i>	Mimosaceae	√	-
2	<i>Azadirachta indica</i>	Meliaceae	√	√
3	<i>Canthium dicoccum</i>	Rubiaceae	√	√
4	<i>Carissa carandas</i>	Apocynaceae	-	√
5	<i>Carissa spinarum</i>	Apocynaceae	-	√
6	<i>Celtis philippensis</i>	Ulmaceae	-	√
7	<i>Choloroxylon swietenia</i>	Rutaceae	√	-
8	<i>Diospyros montana</i>	Ebenaceae	-	√
9	<i>Erythroxylum monogynum</i>	Erythroxylaceae	√	√
10	<i>Feronia elephantum</i>	Rutaceae	√	-
11	<i>Ficus bengalensis</i>	Moraceae	-	√
12	<i>Ficus microcarpa</i>	Moraceae	-	√
13	<i>Ficus racemosa</i>	Moraceae	-	√
14	<i>Ixora pavetta</i>	Rubiaceae	-	√
15	<i>Morinda tinctoria</i>	Rubiaceae	√	√
16	<i>Santalum album</i>	Sanatalaceae	√	√
17	<i>Syzygium cumini</i>	Myrtaceae	√	√
18	<i>Tamarindus indica</i>	Cesalpiniaceae	√	√
19	<i>Zizyphus mauritiana</i>	Rhamnaceae	-	√
20	<i>Zizyphus oenoplia</i>	Rhamnaceae	-	√
21	<i>Naringi crenulata</i>	Rutaceae	-	√
22	<i>Murraya paniculata</i>	Rutaceae	-	√

Table 65. Trees suggested for planting in the scrub jungles of Chengalpet/Kanchipuram and Chennai

S.No	Plant Name	Family	Food source for birds	
			Nectar	Fruit
1	<i>Azadirachta indica</i>	Meliaceae	√	√
2	<i>Butea monosperma</i>	Fabaceae	√	-
3	<i>Canthium dicoccum</i>	Rubiaceae	√	√
4	<i>Cassia fistula</i>	Caesalpiniaceae	√	-
5	<i>Erythroxylum monogynum</i>	Erythroxylaceae	√	√
6	<i>Ficus benghalensis</i>	Moraceae	-	√
7	<i>Flacourtia indica</i>	Flacourtiaceae	-	-
8	<i>Ficus religiosa</i>	Moraceae	-	√
9	<i>Lannea coromandelica</i>	Anacardiaceae	-	√
10	<i>Maba buxifolia</i>	Ebenaceae	-	√
11	<i>Manilkara hexandra</i>	Sapotaceae	√	√
12	<i>Memecylon umbellatum</i>	Melastomataceae	-	√
13	<i>Pongamia pinnata</i>	Fabaceae	√	-
14	<i>Strychnos potatorum</i>	Loganiaceae	√	√
15	<i>Streblus asper</i>	Moraceae	-	√
16	<i>Syzygium cumini</i>	Myrtaceae	√	√
17	<i>Wrightia tinctoria</i>	Rubiaceae	√	-
18	<i>Walsura trifolia</i>	Meliaceae	√	√
19	<i>Ziziphus oenoplia</i>	Rhamnaceae	√	√
20	<i>Ziziphus mauritiana</i>	Rhamnaceae	√	-

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