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Studies of Avian Frugivory in Alagar Hills, Eastern Ghats, India

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Abstract: The paper describes the avian frugivores of Alagar Hills, Eastern Ghats, India. Phenological observations and Extended feeding observations were made on 12 woody plant species belonging to 7 families. Moraceae constituted the dominant families with3 species each. *Ficus benghalensis*, *Syzygium cumini*, *Ziziphus oenoplia*, *Ficus religiosa* and *Ficus racemosa* were found to be the most favoured fruit species in the study area. Bird species of families Pycnonotidae (bulbuls) (2 species; *Pycnonotus cafer*, *Pycnonotus luteolus,)*, Muscicapidae with 2 species (babblers) (*Turdoides affinis*, *Turdoides striatus*), Corvidaea (Asian Koel, House Crow), Sturnidae (Common myna, Brahminy myna) constituted a major share of frugivores.

Key words: Avian frugivory, Alagar hills, Eastern Ghats, India

I. INTRODUCTION

A. Biodiversity

Biodiversity or its physical manifestation- the biological resources are the basis of life on earth. It is an ecological imperative that we depend on them for our basic existence. The floral diversity of the world supports human life in many practical ways such as for food, clothing and shelter. One of the most fundamental contributions of the plant diversity for human survival is in the supply of food. Deforestation is a global threat to biodiversity and ecosystem services [1]. While considerable areas of cleared land have reverted to secondary forest, and there have been increasing efforts to reforest degraded land, the rate of deforestation still greatly exceeds the rate of reforestation [2]. Large-scale reforestation is considered necessary to offset ecological degradation in extensively-cleared tropical and subtropical landscapes [3]. The barriers to regeneration are seed and seedling predation, changes to the physical, chemical and biological properties of soils, and ongoing disturbances, particularly fire [4]. The conservation of existing biodiversity will not only improve the productivity and tree cover of the study area, but also the overall species composition of the region. Birds form an important component of the diverse fauna of any region and are considered as the best indicators of the environment [5] and hence, widely used for ecological studies and in conservation planning.

B. Plant-bird interactions

The study of interactions between avian frugivores and plant species is important for identifying the roles that individual disperser species play in plant recruitment dynamics, thus having implications for both theoretical understanding of mutualisms, species interactions, and modeling vegetation change, and for applied work, including conservation and restoration [6] . The interactions between frugivores and plant species within communities have been represented as networks, where each species (of plant or frugivore) can interact with one or more other species, the analysis of network structure can advance our understanding of complex ecosystems and allow predictions of the consequences of avian species extinctions for the process of seed dispersal, and hence the plant community. Avian frugivores are considered the most important seed dispersers in most ecosystems, as assessed by the numbers of successful propagules disseminated [7, 8]. Fruit-eating birds play a critical role in the functioning of tropical ecosystems and may assist in the natural regeneration of rain forests by dispersing seeds into cleared areas [9, 10, 11].

Frugivores can shape plant populations in varied ways that involve interactions between foraging decisions and the spatial configuration of fruiting plants – decisions that could ultimately affect plant spatial configuration itself [12]. For example, frugivores can direct seeds towards other fruiting plants and habitats [13]. Frugivores also behave predictably with respect to fruit crop sizes [14], fruiting neighborhoods[15] and the location of fruit resources in space and time [16].

In India most of the studies on fruigivory have focused on asingle plant or animal species [17, 18, 19, 20] with very few community level studies [21, 22, 23, 24], dry deciduous forest, knowledge on the relative attractiveness of native plants to frugivorous birds is useful in planning afforestation because fruiting trees will attract birds which dispersed the seeds, thus increasing the diversity of the forest [25]. Study on the relationship between fruit characters (fruit color, fruit size) which attract the birds are studied very less. Very few studies on fruiting seasonality of the bird- dispersed trees have been studied in the tropical dry deciduous forest, Southern India [26]. With this background and

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understanding, a study on fruit – frugivore interactions in the forests of Alagar hills is proposed. Hence this proposal aims for the conservation of forests through afforestation indirectly by seed dispersal through birds.

II. OBJECTIVES

The objectives of the proposed study are to undertake the following components of research works

- Study the fruiting phenology of fleshy fruited species, consumed by birds.
- Assess fruit characteristics such as size and color of fleshy fruited species and relate with the fruit preferences of birds.
- Study the fruit – frugivore interactions in Alagar hills, Eastern Ghats, India.

III. STUDY AREA

The reserve forest of Alagar hills is 20 km North – East of Madurai city and th elevation reaches 880 mts. The Alagar hills lies approximately between 77º 30' and 78º 20' East longitude and 10º 05' – 10º 09' North latitude. The area of the hill is 6813 hectares and there are two springs, Garuda theertham, a seasonal one and the perennial Nupuragangai. The deciduous forests of Alagar hill are composed of both disturbed and protected vegetation. The highest peak, Thalaianaiparai (879m) is situated in the center of the reserve forest. The valley that connects the foot hills and Nupuragangai is called Silambar valley, and it lies to the south west of Thalaianaiparai (6km). Another famous pilgrim center, a temple of Lord Muruga is situated (350m) in the middle of this valley, just below Nupuragangai. Silambar valley, being a pathway to both pilgrim centers is subjected to heavy anthropogenic stress.

IV. METHODOLOGY

A. Phenology

A total of 60 individuals of woody species belonging to 12 species were marked with aluminum tags and observed for phenology (Table I).

The phenology of fruit production was observed twice in a month to assess the periodicity of fruiting. During the observation, percentage fruiting was noted for each tagged individual. Phenological observations were carried out for a continuous period of 12 months.

TABLE I WOODY SPECIES TAGGED FOR PHENOLOGY STUDIES IN ALAGAR HILLS, MADURAI

S. No.	Name of the plant	Family
1.	*Azadirachta indica*	Meliaceae
2.	*Canthium dicoccum*	Rubiaceae
3.	*Carissa spinarum*	Rubiaceae
4.	*Carmona retusa*	Cordiaceae
5.	*Ficus benghalensis*	Moraceae
6.	*Ficus racemosa*	Moraceae
7.	*Ficus religiosa*	Moraceae
8.	*Flacourtia indica*	Flacourtiaceae
9.	*Melia azedarach*	Meliaceae
10.	*Syzygium cumini*	Myrtaceae
11	*Ziziphus mauritiana*	Rhamnaceae
12	*Ziziphus oenoplia*	Rhamnaceae

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B. Bird foraging observations

Foraging observation was made by extended bird feeding watches on fruit-bearing plants. Plants with good visibility were selected for extended feeding watches. Observations were made between 6.00 and 9.00 hours on the bird visitation to the focal tree, with the help of binoculars. The visit by each individual bird followed by pecking/swallowing of fruits were considered as a fruit-feeding visit by a bird Certain birds, particularly carnivores and insectivores simply perching on trees were not included in this observation as they are not frugivores. For each species of plant, three individuals were observed for 12 hours each. Thus, a total of 36 hours of observations was made for each plant species. Plants selected for observation had drupes, berries or similar soft fruits having one or a few seeds or with composite fruits with many small seeds (Moraceae).

C. Fruit colour and Fruit size

Colours of ripe fruits for plant species were assigned to one of eight broad colour categories as used in [27]. Diameter of the fruits were measured using vernier calipers.

V. RESULTS AND DISCUSSION

A. Phenology

Phenological observations were made on 12 woody plant species belonging to 7 families. This included 3 species of figs and 9 species of non-figs.

A fruiting peak was observed during September, with 6 species. Species in fruits during September were *Ficus benghalensis, F.religiosa, F.racemosa.* (Fig.1). A dip was observed during December where only 2 species had fruits, viz. *Ziziphus oenoplia* and *Ziziphus mauritiana* (Fig.1).

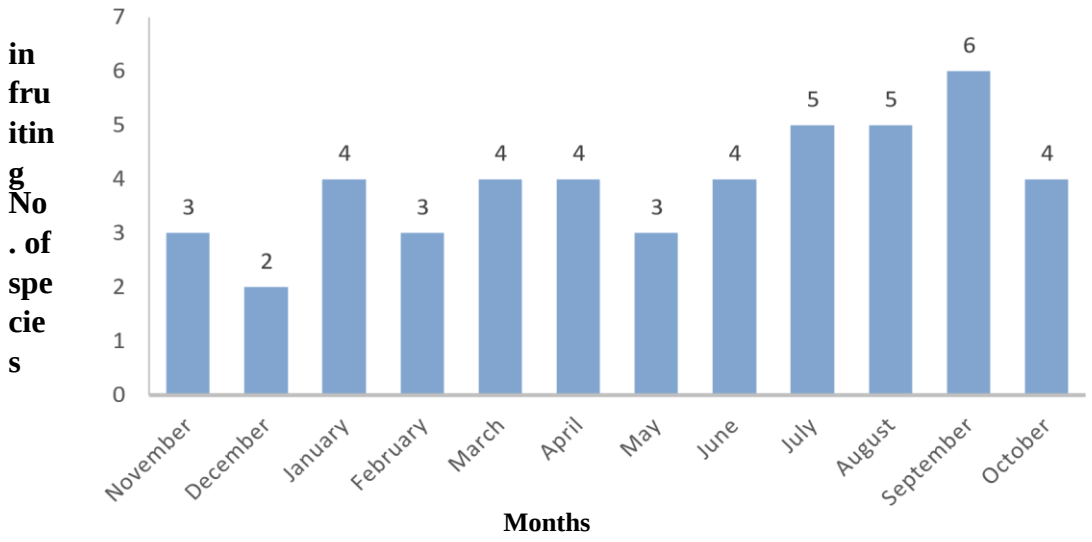

Fig. 1 Phenology of fleshy fruited plants in Alagar hills forest. (No. of species in fruiting).

B. Bird - dispersed plants

Extended feeding observations were made on 12 plant species belonging to 7 families. (Table I).Moraceae constituted the dominant families with 3 species each (Fig. 2). *Ficus benghalensis, Syzygium cumini, Ziziphus oenoplia, Ficus religiosa* and *Ficus racemosa* were found to be the most favoured fruit species in the study area. (Fig.3)

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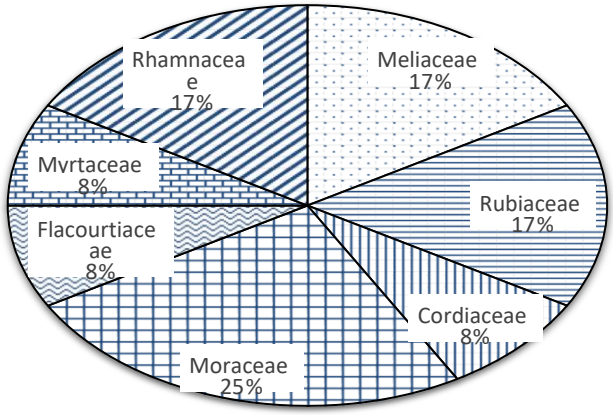

Fig.2 Dominant plant families in the study area

C. Avian frugivory

Other than figs, major bird attracting species in the forest include *Canthium dicoccum, Syzygium cumini, Ziziphus oenoplia, Carissa spinarum, Carmona retusa* and *Azardirachta indica,etc*(Table II)

TABLE II. OBSERVED FRUGIVORY BY BIRDS IN THE FOREST.

S.No	Plant Name	Life form	Family	Fruit type	Ripe fruit colour	Fruit size (cm)	No. of bird species visited
1	*Azadirachta indica*	Tree	Meliaceae	Drupe	Yellow	1.75	3
2	*Canthium dicoccum*	Tree	Rubiaceae	Drupe	Black	1.73	5
3	*Carissa spinarum*	Shrub	Rubiaceae	Drupe	Black	1.51	4
4	*Carmona retusa*	Shrub	Cordiaceae	Drupe	Brown	0.90	5
5	*Ficus benghalensis*	Tree	Moraceae	Synconium	Red	1.17	9
6	*Ficus racemosa*	Tree	Moraceae	Synconium	Red	2.03	7
7	*Ficus religiosa*	Tree	Moraceae	Synconium	Pink	1.14	6
8	*Flacourtia indica*	Tree	Flacourtiaceae	Berry	Black	1.75	5
9	*Melia azedarach*	Tree	Meliaceae	Drupe	Yellow	1.76	4
10	*Syzygium cumini*	Tree	Myrtaceae	Berry	Black	1.60	7
11	*Ziziphus mauritiana*	Tree	Rhamnaceae	Drupe	Red	1.03	3
12	*Ziziphus oenoplia*	Shrub	Rhamnaceae	Drupe	Black	0.61	7

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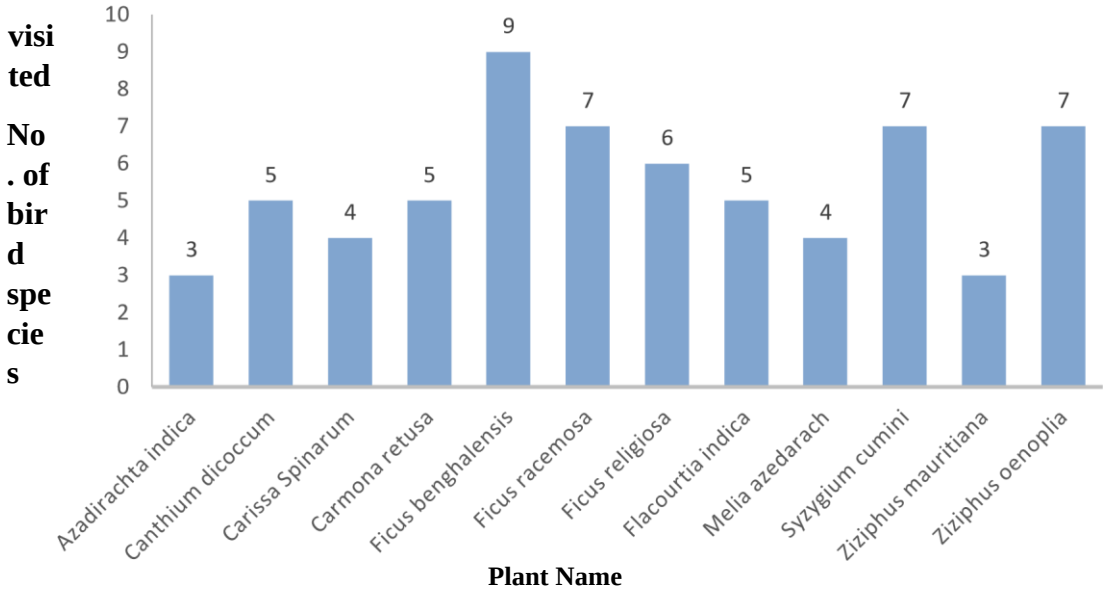

Fig. 3 Number of bird species feeding on each plant species

D. Morphological classification of bird dispersed fruits

The fruit types of all the 12 species were determined. Drupes were the predominant fruit type (58%) followed synconium (25%) and berries (24%). (Fig. 4).

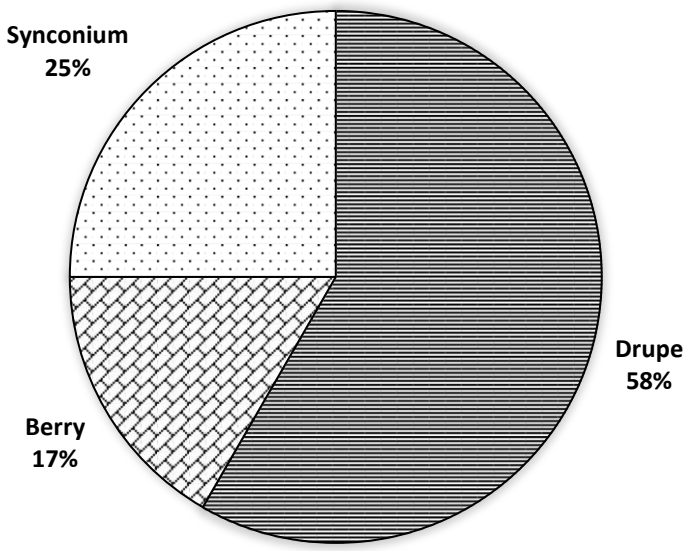

Fig.4 Morphological classification of bird-dispersed fruits

E. Fruit colour

Avian frugivores favored fruit colour include black (42%) followed by red (25%) and yellow (17%). (Fig.5)

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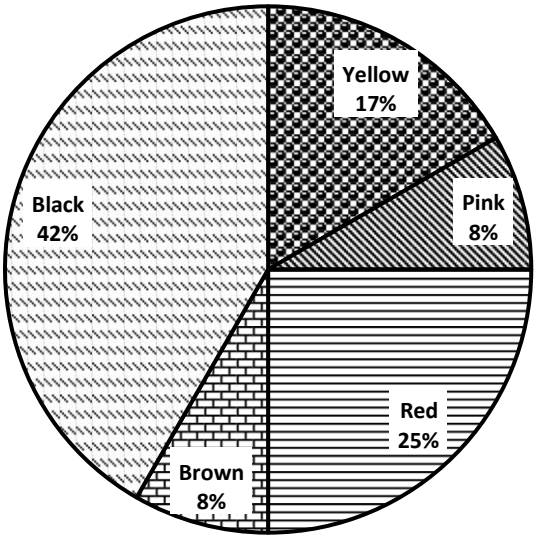

Fig.5 Fruit colour preferences by avian frugivores

F. Fruit size

Fruits' size ranged from 0.61cm (*Ziziphus oenoplia*) to 2.03cm (*Ficus racemosa*) in the study area. More visits were observed in both short sized and large sized fruits. Fruit size didn't have any significance importance in the selection of fruits by avian frugivores in this study area.

G. Avian frugivores

In the study area a total of 13 bird species from nine families have been recorded to eat fruits (Table III). Bird species of families Pycnonotidae (bulbuls) (2 species; *Pycnonotus cafer, Pycnonotus luteolus,*), Muscicapidae with 2 species (babblers) (*Turdoides affinis, Turdoides striatus*), Corvidaea (Asian Koel, House Crow), Sturnidae (Common myna, Brahminy myna) constituted a major share of frugivores.

TABLE III AVIAN FRUGIVORES OBSERVED IN THE FOREST.

S.No	**Common Name**	**Scientific Name**	**No. of visits**	**Body mass (g)**
1	Common Myna	*Acridotheres tristis*	375	98
2	Red-vented Bulbul	*Pycnonotus cafer*	267	35
3	House Crow	*Corvus splendens*	223	280
4	White-headed Babbler	*Turdoides affinis*	201	40
5	Jungle Babbler	*Turdoides striatus*	187	77
6	Asian Koel	*Eudynamys scolopacea*	164	167
7	Eurasian Golden Oriole	*Oriolus oriolus*	103	65
8	White-browed Bulbul	*Pycnonotus luteolus*	98	35
10	Coppersmith Barbet	*Megalaima rubricapilla*	72	38

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11	Indian Treepie	*Dendrocitta vagabunda*	58	128
12	Rose-ringed Parakeet	*Psittacula karmeri*	31	139
13	Brahminy Myna	*Sturnus pagodarum*	8	54

H. Major frugivorous birds

In the forest Common Myna (Sturnidae) formed the most dominant avian frugivore which fed on 9 plant species, followed by Red-vented Bulbul constituted with 8 species in its diet, followed by White headed babbler with 6 species.The list of avian frugivores and the number of plants utilized by them are given in the Table IV.

TABLE IV AVIAN FRUGIVORES OBSERVED IN THE FOREST.

S.No	Common Name	Scientific Name	Family	No. of species
1	Common Myna	*Acridotheres tristis*	Sturnidae	9
2	Red-vented Bulbul	*Pycnonotus cafer*	Pycnonotidae	8
3	White-headed Babbler	*Turdoides affinis*	Muscicapidae	6
4	House Crow	*Corvus splendens*	Corvidae	5
5	Jungle Babbler	*Turdoides striatus*	Muscicapidae	5
6	Asian Koel	*Eudynamys scolopacea*	Cuculidae	4
7	Eurasian-golden Oriole	*Oriolus oriolus*	Oriolidae	4
8	Common Iora	*Aegithina tiphia*	Irenidae	4
9	Coppersmith Barbet	*Megalaima rubricapilla*	Capitonidae	2
10	Indian Treepie	*Dendrocitta vagabunda*	Corvidae	2
11	Rose-ringed Parakeet	*Psittacula karmeri*	Psittacidae	2
12	White-browed Bulbul	*Pycnonotus luteolus*	Pycnonotidae	1
13	Brahminy Myna	*Sturnus pagodarum*	Sturnidae	1

VI. SUMMARY AND CONCLUSION

Phenological observations were made on 12 woody plant species belonging to 7 families. This included 3 species of figs and 9 species of non-figs. A fruiting peak was observed during September, with 6 species. Species in fruits during September were *Ficus benghalensis, F.religiosa, F.racemosa.* A dip was observed during December where only 2 species had fruits, viz. *Ziziphus oenoplia* and *Ziziphus mauritiana.* Extended feeding observations were made on 12 plant species belonging to 7 families.

Moraceae constituted the dominant families with3 species each (Fig. 2).*Ficus benghalensis, Syzygium cumini, Ziziphus oenoplia, Ficus religiosa* and *Ficus racemosa* were found to be the most favoured fruit species in the study area. Other than figs, major bird attracting species in the forest include *Canthium dicoccum, Syzygium cumini, Ziziphus oenoplia, Carissa spinarum, Carmona retusa* and *Azardirachta indica*, the fruit types of all the 12 species were determined. Drupes were the predominant fruit type (58%) followed synconium (25%) and berries (24%). Fruits' size ranged from 0.61cm (*Ziziphus oenoplia*) to 2.03cm (*Ficus racemosa*) in the study area. More visits were observed in both short sized and large sized fruits. Fruit size didn't have any significance importance in the selection of fruits by avian frugivores in this study area.In the study area a total of 13 bird species from nine families have been recorded to eat fruits. Bird species of families Pycnonotidae (bulbuls) (2 species; *Pycnonotus cafer, Pycnonotus luteolus*), Muscicapidae with 2 species (babblers) (*Turdoides affinis, Turdoides striatus*), Corvidaea (Asian Koel, House Crow), Sturnidae (Common myna, Brahminy myna) constituted a major share of frugivores. Forest regeneration is the need of the hour.The project results have short listed the fleshy fruited woody species of plants that are frequently fed by avian frugivores. Instead of planting invasive trees, if we plant these frugivore attracting trees like *Ficus, Canthium, Syzygium* it supports a lot of biodiversity.

The overall health of the ecosystem is well maintained and if the fleshy fruited bird attracting trees are planted more the biodiversity will improve more

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