

FRUGIVOROUS BIRDS AND FRUIT PLANTS IN A DECIDUOUS FOREST IN BANGLADESH: A CASE STUDY IN THE MADHUPUR NATIONAL PARK

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Abstract: A total of 29 species of frugivorous birds were recorded from the Madhupur National Park during July 2007 to December 2008. Among the frugivorous birds, 16 (55.2%) were absolutely seed gulpers, 2 (6.9%) seed gulpers as well as seed discarders and 5 (17.2%) were fully seed predators. The frugivorous birds were observed more active during early morning (23 species, 79.3%) and late afternoon (20 species, 69%), of which 16 (55.2%) were common in both time frames. Frugivorous birds mainly preferred fruit followed by nectars, seeds and buds. *Ficus benghalensis* was the top most preferred food plant to the birds. Berries were highly preferred (29.7%) by the birds. The preferred fruit diameter ranged from 16.5 to 19.6 mm (18.1 ± 0.8). Black colour and mild sweet fruit was highly preferred by the birds.

Key words: Fruit eating birds, fruit plants, deciduous forest, Bangladesh.

INTRODUCTION

Birds are considered a good indicator of the biodiversity. Because they occupy a wide range of habitats from open field to forest, desert to high-mountain and even to ice zone, can reflect change in other animals and plants, can be sensitive to environmental change and they tend to be near or at the top of the food chain (Estrada *et al.* 1993). Birds are, therefore, good indicators of healthy forests and natural environment.

Frugivorous are those birds that feed primarily on fruits and seeds for their survival (Anon. 2008). In tropical rainforest, fruit-eating birds are particularly important seed dispersers, because up to 75% of tree species produce fruits eaten by birds (Herrera *et al.* 1994). Frugivorous birds have the basic mechanism of seed dispersal that allows birds to carry seeds from the parent plants to the new environment for their successful germination (Levey *et al.* 2002). Most of the plants are dispersed and spread populations through their seeds and spores (Terborgh 1986).

Frugivorous birds usually depend on fruits provided by the plants of both natural and planted. Besides they also devour nectars, flowers, buds, seeds and insects during fruit lean period. However, specific dietary information on

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frugivorous birds is limited. In such cases, fruit-seed crushing behaviour and relative dietary dominance by fruits may be used to describe the role of frugivores in seed dispersal. Successful seed dispersal is the out come of a mutual interaction between birds and plants (Anon 2008). Fruit morphology, such as fruit and seed size, and seed geometry affect food choice of birds (Herrera 1984, Howe 1984, Murray *et al.* 1993).

No published work on food, food plant preference and food composition of frugivorous birds of deciduous forest in Bangladesh is on record. This work has provided information on food, feeding, foraging and food preference of frugivorous birds in Bangladesh. So, an attempt was taken to do that to make a base line of future research on the frugivorous bird species in Bangladesh. The objectives were to: (a) record frugivorous bird species in a deciduous forest, (b) find out different foraging activities, and (c) enlist plant species which were used by birds for food items.

MATERIAL AND METHODS

The study was carried out at the Madhupur National Park (MNP), Tangail, Bangladesh during July 2007 to December 2008. It is situated in the northern part of Bhawal-Madhupur *Shal* (*Shorea robusta*) forest tract (24° to 25°15' N and 90° to 91° E, about 20 m above the mean sea level), 151 km north of Dhaka, the capital of Bangladesh and 50 km south of the Garo Hills of the Meghalaya State of India. Madhupur *Shal* forest includes an area of about 24,150 ha, but the Madhupur National Park (wildlife and recreation area) encompasses an area of 8,430 ha.

The forest is partly dense and partly thin including some scrub jungles and human settlements. There are numerous depressions with gentle slope intercepting the ridges. Flat ridges run north to south forming the irregular masses of high lands with gentle slopes. In rainy season, the low-lying depressions accumulate water and become marshy. These marshy places dry up in summer and winter seasons but they expand into broad shallow areas. These shallow swampy areas are covered with grasses and reeds, and harbour some aquatic birds.

The climate is moderate and warm weather spread over March to October; maximum temperature was 37.6°C in April 2008. The cold weather lasts from November to February with a minimum temperature of 7.8°C recorded in February 2008. The monthly average rainfall was about 154.7 mm and the yearly 2,091 mm. The average maximum humidity varied from 97 to 100% and minimum 20 to 58%. The MNP is dominated by *Shal* trees associated with other tree species.

The area was surveyed fortnightly from 0500 to 1800 h. The working schedule was 2 - 3 days in each visit. The time schedule was depending on the seasonal variations. The survey was carried out through simple, Transect Sampling (Buckland *et al.* 2001) technique. Each transect was repeated twice in

a day. The observation-range varied from 20 to 25 m depending on the visibility of the study area.

All bird species were identified following Ali and Ripley (1996) and Grimmett *et al.* (1998). Observations were made with naked eyes and with the help of a pair of binoculars (Bushnell 20 X 280 mm with multicoated lens) depending on the distance. Plant parts other than fruits eaten by the frugivorous birds were also recorded.

The local status of each species of bird was assessed based on the percentage of occurrence during observations (Khan 1982): Very Common (VC), Common (C), Fairly Common (FC), and Rare (R).

Food (fruit and seed) handling techniques (swallow the whole fruit, crushing before swallowing, pecking the fruit and cracking the seed) of different fruit eating birds were recorded in long hand notes. Data of handling techniques based on fruit size, shape, colour and taste were recorded. Feeding patterns, feeding association, feeding methods and canopy utilization by the frugivorous birds were also recorded through direct field observations.

The diets (fruit, seed, nectar, petal and bud) were assessed by direct feeding observations during transect walks. Samples of fruits and seeds were collected throughout the study period, regardless of whether they were eaten or not. The size of fresh fruits and seeds were measured with digital calipers (0" - 6"/0 - 150 mm) and weighed with a digital pocket balance (Kern Germany, Max = 60 g, d = 0.01 g) at the field station. The measurements were taken from 30, sometimes from 10 fruit samples to establish an average.

RESULTS AND DISCUSSION

Frugivorous bird species: Twenty-nine species of frugivorous birds were recorded from MNP (Table 1), which comprised 5 orders and 11 families. The highest number (7 i.e., 24%) of frugivorous birds species belong to the Family Corvidae. Anon. (2008) reported that the highest number of frugivorous birds (6) came from the Family Columbidae from five protected areas in Bangladesh. The families Centropodidae, Irenidae, Zosteropidae and Sylviidae comprised the lowest number (1 i.e., 3%) of frugivorous species.

Among the recorded frugivorous birds, 17 were locally very common, 8 were common, 3 were fairly common and only one was rare.

Category of frugivorous birds: The frugivorous birds were categorized as seed gulpers- swallow whole fruit or fruit part containing seed (Gosper *et al.* 2005), seed discarders- take part or whole fruit without ingesting the seed (Jordano 1995) and seed predators- lethally damage the seed during foraging, either during mandibulation or during gut passage (Gosper *et al.* 2005). Among the frugivorous birds in MNP, 16 (55.2%) were absolutely seed gulpers, 2 (6.9%) seed gulpers as well as seed discarders, 5 (17.2%) fully seed predators and the rest 6 (20.7%) were nectar drinker as well as insect eater.

Table 1. Recorded frugivorous bird species at the Madhupur National Park.

Order Family	Common Name	Scientific Name	Code used
Piciformes			
Megalaimidae	1. Lineated Barbet	<i>Megalaima lineata</i> (Vieillot 1816)	LB
	2. Coppersmith Barbet	<i>Megalaima haemacephala</i> (Muller 1776)	CB
	3. Blue-Throated Barbet	<i>Megalaima asiatica</i> (Latham 1790)	BTB
Cuculiformes			
Centropodidae	4. Asian Koel	<i>Eudynamys scolopacea</i> (Linnaeus 1758)	AK
Psittaciformes			
Psittacidae	5. Rose-ringed Parakeet	<i>Psittacula krameri</i> (Scopoli 1769)	RRP
	6. Red-breasted Parakeet	<i>Psittacula alexandri</i> (Linnaeus 1758)	RBP
Columbiformes			
Columbidae	7. Yellow-footed Green Pigeon	<i>Treron phoenicoptera</i> (Latham 1790)	YFGP
	8. Thick-billed Green Pigeon	<i>Treron curvirostra</i> (Gmelin 1789)	TBGP
	9. Orange-breasted Green Pigeon	<i>Treron bicincta</i> (Jerdon 1840)	OBGP
Passeriformes			
Irenidae	10. Golden-fronted Leafbird	<i>Chloropsis aurifrons</i> (Temminck 1829)	GFLB
Corvidae	11. Large Cuckooshrike	<i>Coracina macei</i> (Lesson 1831)	LCS
	12. House Crow	<i>Corvus splendens</i> (Vieillot 1817)	HC
	13. Large-billed Crow	<i>Corvus macrorhynchos</i> (Wagler 1827)	LBC
	14. Black-hooded Oriole	<i>Oriolus xanthornus</i> (Linnaeus 1758)	BHO
	15. Black-naped Oriole	<i>Oriolus chinensis</i> (Linnaeus 1758)	BNO
	16. Rufous Treepie	<i>Dendrocitta vagabunda</i> (Latham 1790)	RT
	17. Common Iora	<i>Aegithina tiphia</i> (Linnaeus 1758)	CI
Sturnidae	18. Common Myna	<i>Acridotheres tristis</i> (Linnaeus 1766)	CM
	19. Jungle Myna	<i>Acridotheres fuscus</i> (Wagler 1827)	JM
	20. Asian-pied Starling	<i>Sturnus contra</i> (Linnaeus 1758)	APS
	21. Chestnut-tailed Starling	<i>Sturnus malabaricus</i> (Gmelin 1789)	CTS
Pycnonotidae	22. Red-vented Bulbul	<i>Pycnonotus cafer</i> (Linnaeus 1766)	RVB

Order Family	Common Name	Scientific Name	Code used
	23. Red-whiskered Bulbul	<i>Pycnonotus jocosus</i> (Linnaeus 1758)	RWB
Zosteropidae	24. Oriental White-eye	<i>Zosterops palpebrosus</i> (Temminck 1824)	OWE
Sylviidae	25. Jungle Babbler	<i>Turtoides striatus</i> (Dumont 1823)	JB
Nectariniidae	26. Purple Sunbird	<i>Nectarinia asiatica</i> (Latham 1790)	PS
	27. Purple-rumped Sunbird	<i>Nectarinia zeylonica</i> (Linnaeus 1766)	PRS
	28. Little Spiderhunter	<i>Arachnothera longirostra</i> (Latham 1790)	LS
	29. Pale-billed Flowerpecker	<i>Dicaeum erythrorhynchus</i> (Latham 1790)	PBF

Foraging time: All the recorded frugivorous birds visited the food plants throughout the day for foraging. These birds were found more active during early morning (23 species, 79.3%) and late afternoon (20 species, 69%). This also supports the observations of Raju (2005) in the Eastern Ghats forests of India. This is because they eat more food in the morning after an overnight fasting and again consume more food at the late afternoon for taking an overnight fasting preparation. The peak activity of fruit-eating occurs in the early morning in tropics (Land 1963, Leck 1969, 1971, McDiarmid *et al.* 1977, Howe 1977, Leighton 1982) and fruit patches become depleted later in the day (Lambert 1987).

Foraging pattern: In MNP 15 (51.7%) species of frugivorous birds were recorded as silent feeders and on the other hand, 14 (48.3%) were found to be noisy feeders. Among the silent feeders, 6 (40%) species were passerines and 9 (60%) non-passerines; 14 (93.3%) species were resident birds and the rest 1 (6.7%) was migratory; all noisy feeder species (100%) were passerines and resident.

Feeding association: Considering the feeding association, frugivorous birds were categorized into three groups: (1) group feeders, (2) solitary feeders and (3) group as well as solitary feeders. The group feeding species were the highest (15 i.e., 51.7% species) followed by solitary feeders (10 i.e., 34.5%) and group and solitary feeders (4 i.e., 13.8%) in MNP. Among the group feeders, 10 (66.7%) species were passerines and 5 (33.3%) non-passerines and all of these were resident species. In case of solitary feeders, 6 (60%) species were passerines, 4 (40%) non-passerines, and 9 (90%) were resident and only 1 (10%) was migratory species. All group as well as solitary feeders were passerines and resident species.

Canopy used: Vertically canopy was classified as: lower (0 – 5 m), middle (5 – 10 m) and upper (10 m >) on the basis of the height from the ground level. Eight

species of birds used all canopies for foraging (27.6% species); 6 species used only upper canopy (20.7%) and on the other hand, 15 species preferred mostly using middle and upper canopies (51.7%).

Feeding methods: Frugivorous birds exercised three techniques (pick, reach up and reach down) to eat fruit. Fifteen species used all three techniques for feeding (51.7%). Thirteen species (44.8%) preferred to pick as well as reach up technique, but only Asian Koel always applied pick method during feeding.

Food preference: Fruit production period and duration of fruit availability might influence the fruit choice. Fruit size, fruit quantity, chance of accessibility of birds, plant structure and fruit taste also have impact on the fruit choice of birds. In the study area during food scarcity period, the frugivorous birds changed their choice from fruits to seeds, nectars and buds. They mainly preferred fruits followed by nectars, seeds and buds (Fig. 1). Blake and Loiselle (1992) found that the availability of fruits depending on season causes dietary shifts by frugivorous animals. Fatem *et al.* (2008) reported that birds consumed young leaves or shoots, ripe fruits, husk of fruits and inflorescence in Papua New Guinea. Beside fruits the frugivorous birds also eat shoots, buds and flower nectars during fruit scarcity (Anon 2008).

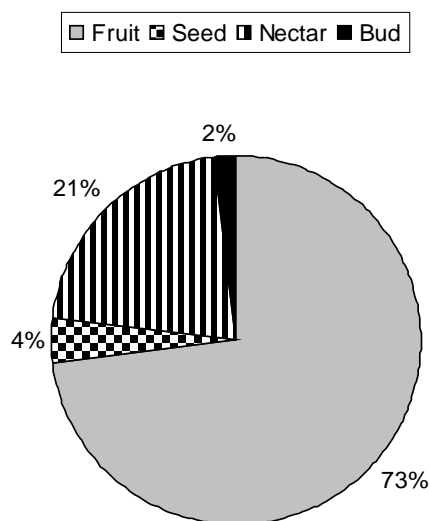


Fig. 1. Percentage of food plant species used in relation to food items.

Fruit handling techniques: All the species used beak for swallowing their foods except 4 species (2 parakeets and 2 crows). Parakeets and crows used beak and feet for eating fruits and seeds. Before swallowing fruit, the Parakeets picked up the fruit by beak, hold the fruit with one foot (either left or right) and ate the fruit pulp with beak and then swallowed. In case of seed, Parakeets picked up the fruit by beak and then cracked the fruit shell to extract/peel the

seed and swallowed. Crows followed to some extent different techniques to eat fruit, they picked up the fruit from the tree branch with their beak and flew away to another branch of the same tree or any other support, then they kept the fruit from the beak on a support and held the fruit with foot (left or right) and then ate the fruit pulp through pecking in little pieces, raised the beak upward and swallowed.

Swallowing methods: During field observations different types of swallowing method (i.e., swallowing whole fruit, crushing fruit before swallowing, plucking before swallowing and seed cracking) were recorded.

Eighteen species (62.1%) preferred to swallow the whole fruit. Seventeen species (58.6%) were observed to pick up the fruit pulp before swallowing. Eight species (27.6%) preferred to crush the fruit before swallowing, and only 5 species (17.2%) were found to crack the seed shell before swallowing the inner part of the seed.

Among the frugivorous birds, Asian Koel, Yellow-footed Green Pigeon, Thick-billed Green Pigeon and Orange-breasted Green Pigeon always swallowed the whole fruit or crushed the fruit before swallowing. House Crow and Large-billed Crow never swallowed the whole fruit; these two species always picked up the fruit pulp through pecking before swallowing. The Lineated Barbet was the only bird, which mostly used crushed method to swallow the fruit, Red-vented Bulbul was the highest pulp picker and Parakeets were the highest seed cracker. Most species of fruit-eating birds either crush fruit during mandibulation, often dropping the seeds, or swallow intact fruits with little mandibulation (Moermond and Denslow 1985).

Time requirement to swallow the food: The time taken/required to manipulate food by frugivorous birds varied from species to species and even within a species depending on the size, texture and parts of the fruits. The Coppersmith Barbet, Green-billed Malkoha, Common Myna, Red-vented Bulbul, Jungle Bubbler and Pale-billed Flower-pecker took minimum time (3 seconds) and Rose-ringed Parakeet took maximum time (80 seconds) to manipulate and swallow food. Foster (1987) noted that usually birds require only a few seconds or less to manipulate the fruit from the tip of the bill to the back of the throat. In fact, birds took short time to manipulate and swallow small and soft textured fruits (e.g., *Trema orientalis*, *Phyllanthus reticulatus*, *Glycosmis pentaphylla*, *Solanum nigrum* and *Clerodendrum viscosum*) and took long time to do so in case of seeds having hard shells (seed coats) (e.g., *Albizia procera*, *Mellotus philippensis* and *Miliusa velutina*).

Monthly variation: The highest number of species recorded in February and May 2008 (18 species, 62.1%) and the lowest in September 2007 and October 2008 (2 species, 6.9%).

Seasonal variation: The highest 22 (75.9%) species was recorded both in winter (November – February) and in pre-monsoon (March – May). On the other

hand, the lowest 21 species (72.4%) was recorded in monsoon (June – October). But Takanose and Kamitani (2003) recorded the highest population of frugivorous birds in the fall (September – November) and the lowest in winter (December – February) in temperate forest of central Japan.

Used food plants by the frugivorous bird species: During this study period frugivorous bird species used 48 species of plants (under 19 families) for food. Among these 12 (25%) species were food plants and 36 (75%) species forest plants.

At MNP 34 species (70.8%) of the 48 food plant species were big trees and the rest small trees (2, i.e., 4.2%), shrubs (9, i.e., 18.7%) and herbs (3, i.e., 6.3%). There was a statistically highly significant difference between the numbers of frugivorous bird species using three plant habits (tree, herb and shrub) during feeding ($\chi^2 = 18.421$, $df = 2$, $p < 0.001$).

The Family Moraceae comprised the highest number of plant species that provided foods to the frugivorous birds (12 species, i.e. 25%) and the second highest Family was Myrtaceae (6 species, i.e., 13%).

Local status of the used food plant species: Among the recorded food plant species used by the frugivorous bird species at MNP, only 1 (2.1%) species was locally Very Common, 7 (14.6%) were Common, 9 (18.7%) Fairly Common and 31 (64.6%) Rare.

Single and multiple fruit producers: During the study period 42 food plant species were recorded as one time fruit producer in a year, 3 species two times producer and 2 species produced fruits 3 or more times in a year.

Preferred food plant species: *Ficus benghalensis* was the top most preferred food plant. This plant species supported the diet of 13 (44.8%) species of birds. Fogden (1970) found that figs are important dietary component for Barbets in Sarawak of East Malaysia. In Trinidad, 13 species of Tanagers and Honeycreepers feed on the fruits of three species of *Ficus* (Snow 1971). The fruits of *Ficus* species are of species interest (Snow 1981). The author also commented that figs are among the most important food of specialized frugivores in Africa, Southeast Asia and Australia.

Food plant preference on the basis of plant family: Food-plants belonging to the Family Moraceae were the most favourites to the frugivorous birds followed (12 species, i.e. 25%) by Myrtaceae and Euphorbiaceae (Fig. 2). The Family Lauraceae, Burseraceae and Palmae get the outstanding importance by the frugivorous birds in Neotropical Region (Snow 1981). The author also stated that fruits of Myrtaceae are regularly taken by both specialized and unspecialized frugivores in all regions. Like the Myrtaceae, many genera of the Euphorbiaceae provide fruits that are eaten by frugivorous birds (Snow 1981). Leighton and Leighton (1983) identified the Meliaceae, Myristicaceae, Annonaceae and Moraceae are being important to the frugivorous birds.

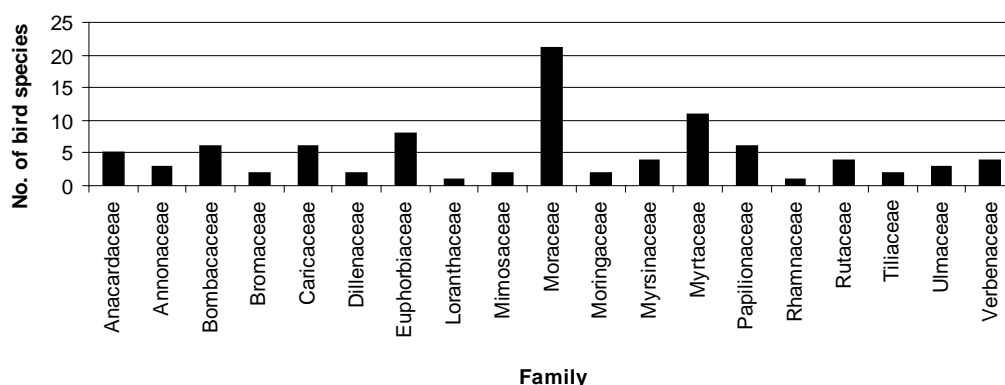


Fig. 2. Food preference on the basis of plant family.

Fruit preference on the basis of fruit type: Frugivorous birds ate 9 types of fruit (Drupe, Berry, Legume, Capsule, Nut, Carcerule, Syconus, Sorosis and Etaerio of Follicles). Among these berries were highly preferred (29.7%). The second preference was both drupe and syconus (21.6%). The difference between fruit types eaten and the number of frugivorous bird species was found to be statistically insignificant ($\chi^2 = 4.12$, $df = 3$, $p > 0.05$).

Fruit preference on the basis of edible parts: Frugivorous birds prefer to eat different parts of the fruit. In MNP, 10 (34.5%) of 29 birds had a preference to eat whole fruit. On the other hand, whole fruit or only mesocarp eating birds were 3.5%, whole fruit or pericarp with mesocarp eaters were 31%, and 3.5% birds preferred only whole fruit or 3 layers of a fruit (pericarp, epicarp and mesocarp). Only epicarp and mesocarp eating birds were 6.9% and mesocarp with seed-eaters were 3.5%. Furthermore, 3.5% birds were recorded to eat young fruits.

Fruit preference on the basis of fruit diameter: The diameter of the edible fruit ranged from 2.1 to 400 mm ($n = 35$ fruit species) and the preferred range varied from 16.5 to 19.6 mm (18.1 ± 0.8) (Fig. 3). Small-fruited plant species attract more species of birds than large fruited ones (Terborgh and Diamond 1970). Fruit and seed size are important in fruit selection for frugivorous birds (Snow 1971, Mckey 1975, Howe and Estabrook 1977, Howe and van de Kerckhove 1980). Kantak (1979) mentioned that the intermediate sized-fruits attracting the greatest number of bird species. The size of bird-dispersed figs at Kuala Lompat ranged from the small (4 mm diameter fig, *Ficus sinuate*) to the relatively huge-sized fig (45.5 X 34.8 mm, *F. subcordata*) (Lambert 1987). Fruits of less than 20 mm diameter are to be primarily adapted for seed dispersal by volant birds (Willson *et al.* 1989).

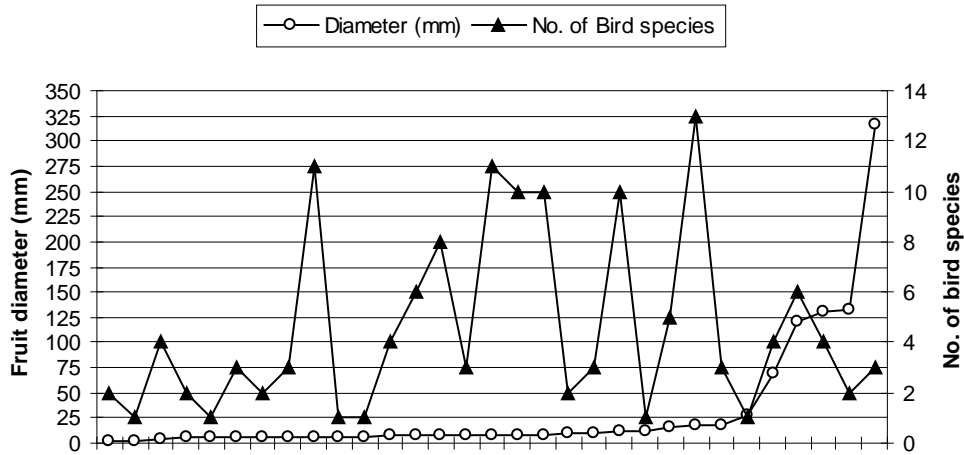


Fig. 3. Fruit preference based on fruit diameter.

Fruit choice on the basis of fruit colour: Altogether 13 colours (yellow, light yellow, black, green, red, light green, brown, yellowish brown, orange, violet, pink, light pink and rusty grey) of fruit were eaten by the frugivorous birds at MNP. Birds highly preferred black coloured-fruits (20.8% of the total used plant species at MNP), this also supports the observations made by Wheelwright and Janson (1985) in Costa Rica, Peru and Florida. Dowselt-Lemaire (1988) mentioned that red/black were the most important colours of fruit eaten by birds. At Point Calimere Wildlife Sanctuary in South India red followed by black coloured fruits are preferred by birds (Balasubramanian 1996). The fruit choice was dominated in the samples are red, green and yellow respectively (Willson and Thomson 1982, Kamruzzaman and Asmat 2008).

Fruit preference on the basis of fruit taste: Seven categories of fruit taste (sweet, mild sweet, sour, mild sour, mild sour with sweet, mild bitter with sweet and tasteless) were eaten by the frugivorous birds in MNP. The birds preferred to eat mild sweet fruits most (22.9% of the used plant species), followed by sweet (20.8% of the exercised plant species), mild sour (16.7% of the exploited plant species) and mixed taste (mild sour with sweet) (6.3% of the utilized plant species). The frugivorous birds in MNP ate only one tasteless fruit (*Bridelia scandens*) and one mild bitter with sweet fruit (*Callicarpa arborea*).

Duration of fruiting time of the used plant species: The fruiting time of plant species, whose fruits were eaten by frugivorous birds in MNP lasted from 2 to 12 months. The fruiting time of 19 exploited species lasted for 2 months, 18 species 3 months, 6 species 4 months and 2 species lasted for 6 months. Furthermore, there were two different species (*Grewia asiatica* and *Carica papaya*), whose fruiting time stretched for 7 and 12 months respectively.

Monthly variation of flowering and fruiting plants: In MNP the flowering time of the used food plant species was maximum (12 species i.e., 25%) during March

and April 2008 and the highest fruiting trees (24 species i.e., 50%) in April 2008, whereas the minimum flowering (1 species i.e., 2.1%) was observed in December 2008 and the lowest fruiting (3 species i.e., 6.3%) in July 2007. Frankie *et al.* (1974) recorded the peak fruiting of fleshy-fruited plants during the dry season in the dry deciduous forest of Costa Rica. The fruiting of maximum species (33) of ornamental and shrub species was observed in the month of March and minimum (11) in October at the Chittagong University Campus of Bangladesh (Hoque 1999).

Highest preference for fruit plant by the bird species: A single species of bird consumed fruits from a variety of food plants as diets; on the other hand, different species of birds also ate from a single species of plant. For instance (Fig. 4), Red-vented Bulbul ate fruits from 38 species of plants in MNP. Eight species of birds (Red-breasted Parakeet, Golden-fronted Leafbird, Black-naped Oriole, Common Iora, Oriental White-eye, Jungle Babbler, Purple Sunbird and Pale-billed Flowerpecker) ate fruit from a single plant species (Fig. 4). Lever (1987) mentioned that various bulbul species are dominant or important frugivores in secondary vegetation throughout tropical and subtropical Asia, as well as much of Africa and the Middle East. Kamruzzaman (2004) also noted that the Red-vented Bulbul visited the maximum number (23) of plants species at the Chittagong University Campus.

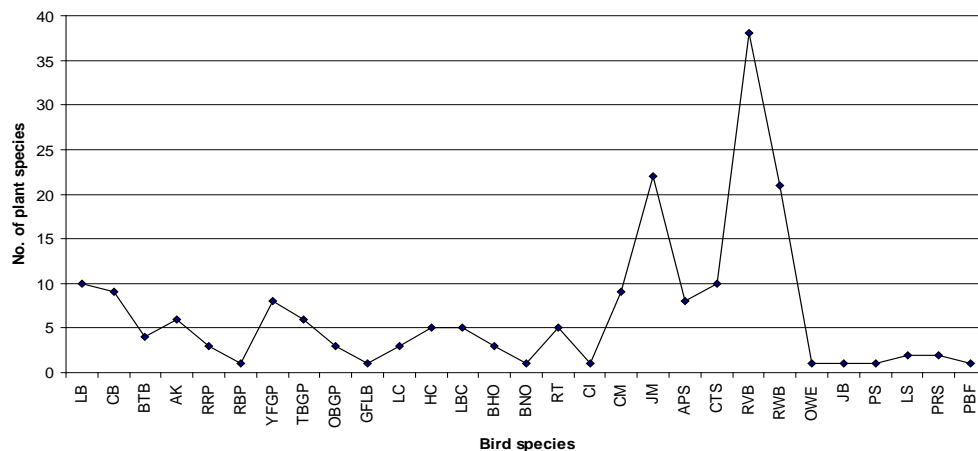


Fig. 4. Number of plant species used by each bird species.

Ornithophily plant species: Pollination by bird is commonly known as ornithophily bird and the plant on which it occurs is termed as ornithophily plant (Fægri and Pijl 1971). Ten (20.8%) species of ornithophily plants were recorded in the MNP. In New Zealand, there are over 30 plant species, whose flowers are visited by birds (Godley 1979, Craig *et al.* 1981). About 100 families of flowering plants are known to have at least some members adapted for bird-pollination (Meeuse and Morris 1984).

Distribution of food plant: Maximum food plant species (81%) were located along the Tangail-Mymensingh Highway, which passes near adjacent the southern boundary line of the national park. Few scattered food plants were observed during the fieldwork. Only a few *Ficus benghalensis* and some *Antidesma ghasembilla* plants were recorded from dense forest of the MNP.

Unused plant species: Fifteen species of fruiting plants (belonging to 11 families) were recorded from the MNP, whose fruits were not used as food by the frugivorous birds (Table 2). Family Euphorbiaceae comprised the maximum number of unused species (i.e., 4).

Table 2. Unused plant species by the frugivorous bird species at MNP.

Sl. No.	Family	Scientific name
1.	Anacardaceae	<i>Laena cormondelica</i>
2.	Combretaceae	<i>Terminalia belerica</i> (Roxb.)
3.	Euphorbiaceae	<i>Aporusa diocia</i> (Roxb.) Muell. (<i>A. roxburghii</i> Baill.)
4.	Euphorbiaceae	<i>Antidesma acidum</i> (Retz.) (<i>A. diandrum</i> (Roxb.) Roth)
5.	Euphorbiaceae	<i>Phyllanthus reticulatus</i> Poir.
6.	Euphorbiaceae	<i>Glochidion multiliculae</i> Muell. Arg.
7.	Lecythidaceae	<i>Barringtonia acutangula</i> (L.) Gaertn.
8.	Leeaceae	<i>Leea alata</i>
9.	Menispermaceae	<i>Cocculus hirsutus</i> (L.) Diels.
10.	Myrsinaceae	<i>Maesa indica</i> Wall
11.	Rubiaceae	<i>Xeromphis spinosa</i> (Thumb.) Keay (<i>Randia dumetorum</i> Lamk.)
12.	Ulmaceae	<i>Trema politoria</i>
13.	Verbenaceae	<i>Duranta repens</i> L. (<i>D. plumeri</i> Jacq.)
14.	Verbenaceae	<i>Clerodendrum serratum</i> R.Br.
15.	Vitaceae	<i>Vitis repensi</i> Wt. & Arm.

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