(2007). In addition, old names as well as the global status after IUCN *et al.* (2004) is provided (Table 1).

Results: Loktak lake provides congenial breeding ground for the different species of frogs. This unique ecosystem has not been surveyed so far for its amphibian faunal richness. This is the first ever record of amphibians from this wetland of international importance. The frogs recorded so far belong to lotic as well as lentic ecosystems. In the present survey we have been able to record 25 amphibian species just from Loktak lake and the neighbouring wetlands, of which 21 species are new records for the state (Table 1). The surrounding area of loktak lake includes some undisturbed habitat and hence we could record some rare frogs like *Xenophrys wuliangshanensis*, *X. major* and three species of *Amolops*. *Xenophrys wuliangshanensis* was first reported as a new record for India from Nagaland (Ao *et al.* 2003), since then the frog has been reported from Arunachal Pradesh (Borah & Bordoloi, 2003) and now from Manipur. *Xenophrys major*, *X. wuliangshanensis*, *X. parva*, *Amolops formosus*, *Amolops gerbillus*, *Humerana humeralis*, *Euphlyctis hexadactylus*, *Fejervarya teraiensis*, *F. nepalensis* and *F. syhadrensis* are new records for the state of Manipur. The 25 species recorded from the area reveals that the area abounds in suitable breeding grounds of diverse groups of frogs. Extensive survey in the Keibul Lamjao National Park may lead to discovering many species not recorded so far.

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OBSERVATIONS ON FRUIT HANDLING TECHNIQUES OF FRUGIVOROUS BIRDS IN CHITTAGONG, BANGLADESH

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Most species of fruit-eating birds either crush fruit during mandibulation, often dropping the seeds, or swallow intact fruits with little mandibulation (Moremond & Denslow, 1985). The predicted differences between the two groups of birds carry important consequences for both fruit-eating birds and fruiting plants. From a plant's perspective, seeds that are swallowed are likely to be deposited farther from the parent tree than seeds dropped during fruit handlings, because survival is higher farther from the parent plant (Janzen, 1970; Connell, 1971; Augspurger, 1984; Augspurger & Kelly, 1984; Clark & Clark, 1984; Howe *et al.*, 1985).

Study area: The Chittagong University Campus lies in between 22°27'30"-22°29'0"N & 91°46'30"-91°47'45"E. The campus is mainly hilly and the total area is 1264.73ac of which 720ac is hills and hillocks and the remaining are either plains or valleys. About 30% of the hills are higher than 70m and the remaining are less than 30m high from the mean sea level. There are some creeks and streams running through the area. The soil varies from clay to clayey-loam in valleys and plains and sandy-loam in hills. The pH of the soil is mostly acidic in nature. There are distinctly four synoptic seasons (Ahmed, 1991) prevailing in the area, namely, pre-monsoon (March to May), monsoon (June to September), post-monsoon (October to November) and winter (December to February). The vegetation of the campus is of semievergreen type. The primary vegetation of this area is totally lost. After the establishment of the University in 1966, plantation of tree species was undertaken. This has gradually changed the vegetation to a secondary type. Vegetables and rice are grown in the plains and in valleys. The grasses, sedges and reeds are also seen in swamps and ditches. About 30% area of the campus consists of road, building, habitations and gardens. About 312.25ac of hills are under plantations. Most of plantations are mixed type, comprising both indigenous and exotic species. Exotic species includes *Eucalyptus* spp., *Acacia* spp., *Meloleuca* spp., *Swetenia* spp., and many others. The planted indigenous species are *Chukrasia* spp., *Albizzia* spp., *Lagerstroemia* spp. among others. Alam and Pasha (1999) have recorded about 665 angiospermic species from the study area. About 600 settlements are situated inside the area. Most of their settlements are situated around the foothills. They practice shifting cultivation. This rich flora attracts and sustains large

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Table 1. Fruit handling techniques by frugivorous birds in the Chittagong University Campus, Bangladesh

Sl. No.	Name of birds	Total observations	Whole swallowed (%)	Pulp pecked (%)	Seed cracked (%)	Crushed before swallowing (%)
1	Pied Myna	23	73.91	21.94	4.35	0
2	Jungle Myna	18	38.89	50.00	11.11	0
3	Grey-headed Myna	22	45.45	40.91	13.64	0
4	Common Myna	2	50.00	50.00	0	0
5	Red-vented Bulbul	48	74.60	21.25	4.15	0
6	Red-whiskered Bulbul	19	73.68	26.32	0	0
7	House Crow	9	33.33	0	11.11	55.55
8	Jungle Crow	3	0	100	0	0
9	Tree Pie	8	25.00	37.50	0	37.50
10	Lineated Barbet	18	77.78	11.11	5.56	5.56
11	Koel	5	100	0	0	0
12	Large Green Barbet	2	50.00	50.00	0	0
13	Small Green Barbet	1	0	0	0	100
14	Blue-throated Barbet	1	100	0	0	0
15	Coppersmith Barbet	6	0	100	0	0
16	Common Iora	1	100	0	0	0
17	Black-headed Oriole	2	100	0	0	0
18	Great Tit	1	0	100	0	0
19	White Eye	1	100	0	0	0

Table 2. The category of frugivory vis-a-vis plants at the Chittagong University Campus, Bangladesh

	Plant species	Number of bird species	Swallower (%)	Pulp pecker (%)	Seed cracker (%)	Crusher (%)
1	*Acacia auricauliformis*	1	100	0	0	0
2	*Aporusa* sp.	3	100	0	0	0
3	*Artocarpus chaplasha*	4	0	100	0	0
4	*Azadirachta indica*	3	0	75	0	25
5	*Bridelia hispida*	1	100	0	0	0
6	*Carica papaya*	4	0	100	0	0
7	*Clerodendrum viscosum*	1	0	100	0	0
8	*Ficus benghalensis*	14	50	42.86	0	7.14
9	*Ficus parasitica*	9	44.44	55.55	0	0
10	*Ficus lepidosa*	1	100	0	0	0
11	*Ficus hispida*	1	0	100	0	0
12	*Ficus religiosa*	1	100	0	0	0
13	*Garuga pinnata*	4	100	0	0	0
14	*Glochidion* sp.	7	0	0	100	0
15	*Grewia asiatica*	1	100	0	0	0
16	*Illex godajam*	6	100	0	0	0
17	*Lannea coromandelica*	5	60	0	40	0
18	*Lantana camara*	4	100	0	0	0
19	*Litsea monopetala*	7	100	0	0	0
20	*Melastoma malabathricum*	3	0	100	0	0
21	*Michelia champaca*	3	0	0	100	0
22	*Phoenix sylvestris*	2	0	100	0	0
23	*Phyllanthus reticulatus*	1	100	0	0	0
24	*Psidium guajava*	1	100	0	0	0
25	*Syzygium cumini*	6	16.67	83.33	0	0
26	*Trema orientalis*	9	100	0	0	0
27	*Vitex peduncularis*	2	100	0	0	0

number of avifauna, both resident and migrant.

Materials and methods: The study was conducted from March 2003 to February 2004. Direct field observations were made on flowering and fruiting phenology, frugivorous bird species, fruit characters and bird choice by fruit-size, colour and taste. The observations were done in the morning to evening at intervals (0500-1200hr & 1400pm-1700hr), once a week. Data on feeding and fruit handling methods (swallowing whole fruit, crushing before swallowing, pecking the fruit and cracking the fruit) were recorded. For watching bird activities a pair of 10x40 binoculars was used.

Results: In the present study, 190 observations of fruit handling by birds were recorded. The list of bird species and the relative frequency of fruit handling techniques followed by each species are given in Table 1. Nineteen species of frugivorous birds were observed handling fruits of 27 plants. The most frequent visitors to the plants were classified into three groups based on their feeding methods: (i) birds that swallowed fruits whole (Pied Myna, Grey-headed Myna, Jungle Myna, Common Myna, Red-vented Bulbul, Red-whiskered Bulbul, House Crow, Treepie, Lineated Barbet, Koel, Large Green Barbet, Blue-throated Barbet, Common Iora, Black-headed Oriole & White Eye); (ii) birds that pecked the fruits to eat pieces of pulp (Jungle Crow, Coppersmith Barbet & Grey Tit); and (iii) birds that cracked the seed after removing the pulp of the fruit (Grey-headed Myna, Jungle Myna, House

Crow, Lineated Barbet & Red-vented Bulbul).

In 5.26% of the observations the birds crushed the fruits before swallowing. Some large soft fruits were eaten in parts, either with seeds (*Ficus* spp.), or the flesh only (*Illex godajam*, *Syzygium cumini* by mynas, bulbuls and barbets), but also the smooth red skin of *Bridelia hispida* by the Red-vented Bulbul. The handling methods depended on the size and type of fruit. All succulent fruits up to 0.25-8.00mm in length or diameter were swallowed whole and fruits with more than 18mm in diameter or length swallowing decreased rapidly, the flesh of larger fruits were usually sucked and the seeds spat/or dropped to the ground (many below the parent tree), except in the small seeded fruits of *Ficus hispida* where the seeds were also swallowed. Pied Myna, Grey-headed Myna, Jungle Myna, and Common Myna swallowed the fruits whole (52.06%), partially pulp pecked (40.66%), and seed cracked (7.28%); the bulbuls (Red-vented & Red-whiskered) swallowed the whole fruit (67.16%) followed by the pulp pecked (29.85%), seed cracked (2.99%); barbets (Lineated, Large Green, Small Green, Blue-throated & Coppersmith) consumed fruits by swallowing (57.14%), pulp pecked (32.14%), crushed before swallowing (7.14%) and seed cracked (3.57%); the corvids (Tree Pie, House Crow & Jungle Crow) preferred to crush before swallowing (40%) followed by pulp pecked (30%), swallowed whole (25%) and seed cracked (5%); Koel, Black-headed Oriole, Common Iora and only White Eye swallowed the whole fruit (100%), but the Grey Tit only pecked the pulp (100%).

Among the fruit plants, 53.92% visitors of total avian frugivore species were swallowers followed by the pulp peckers (32.35%), seed crackers (11.76%) and the crushers (1.96%). The present study has recorded an average of 10 fruit species eaten per bird species, or a total of 190 feeding records. For many fruiting plants (29.63%) feeding records involved only a single bird species, 59.26% was recorded involving three or more bird species. More than 10 bird species were observed for only 3.70% of the plant species (Table 2). Feeding records reflect unequal degree of avian frugivory among different groups. Passerines accounted for a far greater number of feeding records (12.08) than expected by their number of species (mean number of fruit species eaten/bird species = 10.0).

Discussion: Some plants may have coevolved with frugivorous birds at the level of the groups represented by the fruit-handling dichotomy (Levey, 1987). Fruits are generally poor in nutrients and high in bulk (Moermond & Denslow, 1985). Hence, an important adaptation to frugivory is the efficient handling of fruits (Levey, 1987). Wheelwright (1985) demonstrated that fruit-eating birds, like some predators, are "gape-limited" - the sizes of fruits they can take are limited by the size of their gapes. Levey (1987) commented that the birds with small gapes are quite restricted in the number of fruit species they can eat. In the present study, five avian frugivores were found to take fruit only by swallowing. These were not all large-gaped frugivorous birds, such as Koel, Blue-throated Barbet, Black-headed Oriole, Common Iora and White Eye. The Jungle Crow, Coppersmith Barbet and Grey Tit handled fruit by pecking technique. The small Green Barbet swallowed the fruit after crushing, and the House Crow, Tree Pie, Lineated Barbet also partially swallowed specific fruits after crushing (Table 1). Different techniques applied by the same avian frugivore seemed dependant on fruit structure (fleshy-juicy pulps, small/large size), bill type and its strength. Future studies are required that would include more detailed data on the feeding method of the birds and on characteristics of the fruit other than size.

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