

USING MIST-NETS ON CANOPY WALKWAYS IN MALAYSIA TO STUDY CANOPY AVIFAUNA

Mustafa Abdul Rahman

*Institute of Biodiversity and Environmental Conservation,
Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia
Email: rmustafa@mailhost.unimas.my*

ABSTRACT. – The aim of this short-term study was to assess the canopy avifauna by deploying mist-nets on canopy walkways in the tropical rain forest of Malaysia. Twenty-four mist-nets were deployed at height from 5 to 33.3 m on the existing aerial canopy walkways at three study sites; Poring Hot Spring, Sabah; Lambir Hills National Park, Sarawak; and Taman Negara National Park, Peninsular Malaysia. In total, 56 birds were captured representing 39 species and 22 families. Simpson's Diversity Index (SDI) values did not vary significantly between sites. However, there was a difference between the species of birds caught in the canopy mist-nets and those species either seen during the study or commonly caught in conventional mist-nets on the ground. These results suggest that canopy mist-nets deployed on canopy walkways are a useful additional tool in avifauna surveys because they detect species commonly missed by other techniques. In addition, the technique does not require special equipment to assemble, extra cost or time.

KEY WORDS. – Avifauna, canopy, walkways, mist-net.

INTRODUCTION

In the past decade, there has been a substantial interest in studying avifauna in the forest canopy, especially the canopy of the tropical rain forests (Nadkarni & Lowman, 1995). With the aid of binoculars, some birds in the canopy can be identified from the ground. However, ground observations only provide limited data. For instance, it is necessary to capture birds in order to take morphological measurements, collecting museum specimens, blood or other tissues for genetic studies, parasite studies, and to determine the breeding and moulting status of birds. Indeed, in many cases, it is necessary to capture the bird in order to make a positive identification.

Many techniques have been developed in an effort to study the forest canopy. McClure (1966) built a platform 42 m above ground level to study the relationships between animals and the flowering and fruiting of plant species in the canopy of hill-slope forest in Selangor, Malaysia. Similarly, Moffett & Lowman (1995) presented techniques ranging from climbing the trunks of trees up to 40 cm in diameter, construction of vertical towers, cranes, rafts and sleds to the construction of canopy walkways (Fig. 1). The introduction of mist-nets for catching birds has tremendously improved avian research (Karr, 1979). This has led to attempts to study canopy birds using mist-nets. Several researchers have discussed the techniques of capturing canopy birds by hanging mist-nets on high poles, and the

results have been promising, with many previously overlooked species being captured (Greenlaw & Swinebroad, 1967; Humphrey et al., 1968; Meyers & Pardieck, 1993; Munn, 1991; Whitaker, 1972). However, a major drawback of this technique is that it has proven to be extremely time-consuming and requires many man-hours to assemble and check the suspended mist-nets.

The aim of this paper is to introduce a new method of using mist-nets to study canopy avifauna. I present the results of the deployment of mist-nets on pre-existing canopy walkways located at three study sites in Malaysia: Poring Hot Spring (Sabah); Lambir Hills National Park (Sarawak);



Fig. 1. The aerial canopy walkway at Taman Negara National Park.

and Taman Negara National Park (Peninsular Malaysia) (Fig. 2). I then compare these results with the species that I would have recorded had I used the conventional mist-netting techniques, that is, by placing the mist-nets on the ground.

STUDY SITES

Poring Hot Spring. – Poring Hot Spring is located within Kinabalu Park at 579 m above sea level east of Mount Kinabalu which stands at 4101 m. The canopy walkway ($06^{\circ} 02' 40''$ N and $116^{\circ} 42' 17''$ E) where the study was conducted is situated one km from Poring Hot Spring Park Headquarters. It is a lowland dipterocarp forest. The mean annual rainfall ranges between 2000 to 3800 mm and the mean temperature is 28°C .

Mist-nets were deployed along the 216 m long, split level canopy walkway, originally built for tropical rain forests canopy flora and fauna research. The height of every station where mist-nets were deployed was measured using drop-down nylon rope. The length of the nylon rope was then determined by the aid of a 50-m tape. The height of the mist-nets ranges between 10 and 33.3 m above ground with an average height of 20.5 m.

Lambir Hills National Park. – Lambir Hills National Park is located in the state of Sarawak, Malaysia (coordinates of study site: $04^{\circ} 11' 45''$ N, $114^{\circ} 02' 15''$ E). The elevation of Lambir Hills National Park is 100 to 200 m above sea level (Inoue et al., 1995). Lambir Hills National Park received 5000 mm annual rainfall with temperature ranging from 23.2°C to 29.2°C , and relative humidity between 80% and 100% (Momose et al., 1994). Lambir Hills National Park is a lowland dipterocarp forest with emergent layer of about 60 m above ground, dominated by *Dryobalanops* (Dipterocarpaceae), *Swintonia* (Anacardiaceae), and *Koompassia* (Leguminosae), while the canopy layer (about

40 m above ground) was dominated by *Shorea* and *Dipterocarpus* (Dipterocarpaceae), and accompanied by *Scaphium*, *Heritiera* (Sterculiaceae), *Canarium*, *Santilia* (Burseraceae), *Artocarpus* (Moraceae), *Dialium*, *Callerya*, *Sindora* (Leguminosae) and *Eugenia* (Myrtaceae) (Kato, 1996).

The Lambir Hills National Park canopy walkway was built mainly for researches on flora and fauna. The construction and layout of the canopy walkways was described by Inoue et al. (1995). Mist-nets were deployed along the 300 m long aerial walkways that are connected by nine sections that passed through eight piers at various canopy strata. The height of the sampling stations (mist-nets) range between 17.2 and 29.3 m above ground, and the mean height was 23 m.

Taman Negara National Park. – Taman Negara National Park sprawls over three states of Peninsular Malaysia – Pahang, Trengganu and Kelantan. The totally protected area covers 4,343 km². The annual rainfall in the lowland area is about 2,200 mm and the temperature ranges from 26°C in the middle of the day and 22°C at night with humidity of above 90% (Department of Wildlife and National Park, Peninsular Malaysia, 1989).

The canopy walkway ($04^{\circ} 23' 18''$ N, $102^{\circ} 23' 57''$ E) at Taman Negara National Park was built for visitors as well as research. The total length of the canopy walkway is 450 m with eight platforms. Like Poring Hot Spring and Lambir Hills National Park, the forest where the canopy walkway is constructed comprise of trees belonging mainly to the families Dipterocarpaceae, Leguminosae, and Anarcadiaceae. The mean height of the sampling station is 19.2 m and the height ranged between 5 and 28 m above ground.

METHODS

The deployment of mist-nets on aerial canopy walkway at Poring Hot Spring was conducted in July 1996, Lambir Hills National Park in November 1996, and at Taman Negara National Park in April 1997. Four-shelf mist-nets 12 m long and 2.5 m high with 36 mm mesh size, were set at each station. The nets were stretched between two poles of about 12 m in length (Fig. 3). At Poring Hot Spring and Lambir Hills National Parks, the mist-nets were opened from 0600 until 1830 h. At Taman Negara National Park the mist-nets were opened from 0700 to 1100 h. and 1445 h to 1900 h from Saturday to Thursday, and from 0700 to 0900 h and 1200 to 1900 h on Friday. These operating times at Taman Negara National Park were used to accommodate tourist-visiting times.

Eight mist-nets were deployed at Poring Hot Spring. At Lambir Hills National Park, 10 mist-nets were deployed (four on the first day, an additional six mist-nets erected the following day). Six mist-nets were deployed at Taman Negara National Park. The number of net-hour at Poring Hot

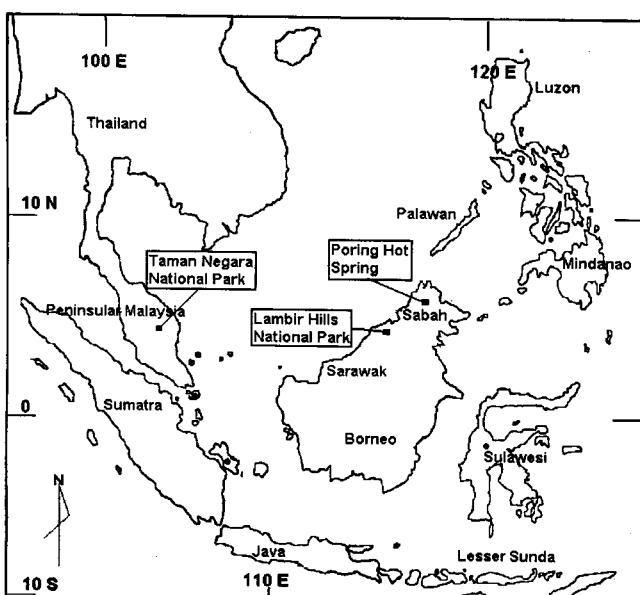


Fig. 2. The map of Southeast Asia showing locations of the study sites.

Spring, Lambir Hills National Park and Taman Negara National Park was 200, 348 and 177 hours, respectively.

The nets were checked every hour. Birds caught in the mist-nets (Fig. 3) were removed and placed in cloth bags. The time, shelf and net number were noted when birds were removed from the nets. The measurements of birds made include weight, tarsus length, bill length, bill depth, bill width, wing length, tail length and total length. The measurements were made using Mitutoyo electronic digital callipers and a steel ruler. The weight was taken using Pesola weighing scale (100 g, 300 g and 500 g). The moulting and brooding stage of the birds were examined and recorded. Finally, a numbered ring was fixed to the bird's tarsus before releasing it. Bird identification was aided by King et al. (1975), MacKinnon & Phillips (1993), and Smythies (1981) with additional information by Lekagul & Round (1991), Davison & Fook (1995a, b).

The relative abundance was calculated by dividing the number of individuals captured by the total number of birds captured at each site ($n/\sum n$). No attempts have been made to compare the capture rates of different levels of mist-nets deployment. As far as this study is concerned, the nets were placed above the canopy of medium-sized trees, within the canopy of large trees and in between the canopy of high emergence trees. In addition to the deployment of mist-nets on the canopy walkways, birds spotted in the vicinity of the canopy walkway were recorded using 7 x 42 binoculars. However, efforts were not made to systematically survey the birds.

Mist-nets were also deployed on the ground at Poring Hot Spring and Taman Negara National Park immediately after canopy mist-netting work ended. The sites selected were about 500 m away from the canopy walkways of both study sites. The nets were opened from 0600 h to 1630 h at Poring Hot Spring and 0700 h to 1930 h at Taman Negara National Park and checked every two hours. The sampling was carried out for three days (306 net-hour) at Poring Hot Spring and four days (259 net-hour) at Taman Negara National Park. To compare species diversity among the three study sites, Simpson's Diversity Index (SDI) was employed (Krebs, 1994).



Fig. 3. A bird entangled in a mist net deployed on the aerial canopy walkway.

RESULTS AND DISCUSSION

A total of 15 birds comprising 11 species and six families were caught in the mist-nets at Poring Hot Spring (Table 1). The means and standard deviations of the external morphological characters are presented in Table 2, 3 and 4. The families Nectariniidae and Capitonidae accounts for the highest number of birds and species captured (33.3%). At Lambir Hills National Park, the family Pycnonotidae accounts for the most number of species (40%) and also the highest number of birds captured (50%). A total of 24 individuals representing 15 species and seven families were captured here (Table 1). Seventeen birds comprising 13 species from nine families were captured at Taman Negara National Park. The highest number of birds captured at this study site belongs to the family Eurylaimidae (29.4%). The differences in the number of species and total number of birds captured are presented in Table 1. The SDI values were very close between sites.

The canopy mist-nets enabled the capture, examination, recording and ringing of several species that would have been missed using conventional techniques. These include Banded bay cuckoo, Blue-eared barbet, Yellow-crowned barbet, Red-throated barbet, Dusky broadbill, Banded broadbill, Lesser cuckoo-shrike, Lesser green leafbird, Streaked bulbul, and Asian fairy bluebird (scientific names of birds are in Table 1). Very rarely, families such as Cuculidae, Capitonidae, Eurylaimidae, Campephagidae, Chloropseidae, Dicruridae and Oriolidae that occupy and forage in canopy were captured when mist-nets were deployed on the ground (Table 5).

Species frequently caught when mist-nets were deployed on the ground include kingfishers, babblers, flycatchers, spiderhunters, sunbirds, flowerpeckers and shama (Lambert, 1992; Wells, 1978; Wong, 1985). Furthermore, species like streaked and grey-bellied bulbul, brown barbet and banded broadbill were rarely caught when mist-nets were deployed on the ground. Location where a bird forages probably results in differences in bird caught on ground rather than in the canopy. If opportunity permits in the future, it would be interesting to carry out studies both on and under the canopy walkway at the same time to compare the data.

The canopy walkways have been found to be useful in studying canopy birds. In this study, only one additional helper was required to help erect the mist-nets. Furthermore, this technique did not require the cutting or slashing of vegetation. In contrast to other canopy mist-netting techniques, this is a straightforward technique that does not require elaborate equipment, special skills or incur extra cost and time to assemble.

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Table 1. Systematic list of species of birds captured at the three study sites. The numbers denote number of birds captured.

Family	Species	Canopy Nets		
		Poring Hot Spring	Lambir Hills National Park	Taman Negara National Park
Cuculidae	Banded bay cuckoo (<i>Cacomantis sonneratii</i>)	1	-	-
Capitonidae	Blue-eared barbet (<i>Megalaima australis</i>)	1	-	-
	Yellow-crowned barbet (<i>M. henricii</i>)	1	-	-
	Red-throated barbet (<i>M. mystacophanos</i>)	-	1	-
	Brown barbet (<i>Caloramphus fuliginosus</i>)	3	5	-
Indicatoridae	Malaysian honeyguide (<i>Indicator archipelagicus</i>)	-	1	-
Picidae	Buff-rumped woodpecker (<i>Meiglyptes tristis</i>)	-	-	1
Eurylaimidae	Dusky broadbill (<i>Corydon sumatrana</i>)	-	1	-
	Banded broadbill (<i>Eurylaimus javanicus</i>)	-	-	1
	Green broadbill (<i>Calyptomena viridis</i>)	-	-	4
Campephagidae	Lesser cuckoo-shrike (<i>Coracina fimbriata</i>)	1	-	-
	Bar-winged flycatcher shrike (<i>Hemipus picatus</i>)	-	-	1
Chloropseidae	Lesser green leafbird (<i>Chloropsis cyanopogon</i>)	-	2	-
Pycnonotidae	Cream-vented bulbul (<i>Pycnonotus simplex</i>)	-	2	-
	Grey-bellied bulbul (<i>P. cyaniventris</i>)	-	1	-
	Puff-backed bulbul (<i>P. eutilotus</i>)	-	1	-
	Spectacled bulbul (<i>P. erythrophthalmos</i>)	-	1	1
	Hairy-backed bulbul (<i>Tricholestes criniger</i>)	-	2	-
	Streaked bulbul (<i>Ixos malaccensis</i>)	-	3	-
	Yellow-bellied bulbul (<i>Alophoixus phaeocephalus</i>)	-	-	1
Dicruridae	Crow-billed drongo (<i>Dicrurus annectans</i>)	2	-	-
Oriolidae	Asian fairy-bluebird (<i>Irena puella</i>)	-	-	1
Timaliidae	White-bellied yuhina (<i>Yuhina zantholeuca</i>)	-	-	1
Sylviidae	Rufous-tailed tailorbird (<i>Orthotomus sericeus</i>)	1	-	-
	Artic warbler (<i>Phylloscopus borealis</i>)	-	-	2
	Black-browed reed-warbler (<i>Acrocephalus bistrigiceps</i>)	-	-	1
Muscicapidae	Pale blue-flycatcher (<i>Cyornis unicolor</i>)	-	1	-

Table 1 (continued). Systematic list of species of birds captured at the three study sites. The numbers denote number of birds captured.

Family	Species	Canopy Nets		
		Poring Hot Spring	Lambir Hills National Park	Taman Negara National Park
Nectariniidae	Plain sunbird (<i>Anthreptes simplex</i>)	1	—	—
	Ruby-cheeked sunbird (<i>A. singalensis</i>)	1	1	—
	Purple-throated sunbird (<i>Nectarinia sperata</i>)	—	—	1
	Little spiderhunter (<i>Arachnothera longirostra</i>)	2	1	—
	Thick-billed spiderhunter (<i>A. crassirostris</i>)	—	1	—
	Grey-breasted spiderhunter (<i>A. modesta</i>)	1	—	1
	Crimson-breasted flowerpecker (<i>Prionochilus percussus</i>)			
	—	—	—	1
	Total number	15	24	17
Total species (Species richness)		11	13	
Total families		6	7	9
Capture rate (birds/1000 net hour)		75	69	96
Simpson's Diversity Index		0.890	0.903	0.893
Overall total individuals		56		
Overall total species		39		
Overall total families		22		

Table 2. Mean and standard deviation of external morphological measurements of birds captured in Poring Hot Spring. Wt = weight (g), tr = tarsus (mm), bl = bill length (mm), bd = bill depth (mm), bw = bill width (mm), hb = head + bill length (mm), wl = wing length (mm), ta = tail length (mm), tl = total length (mm). Scientific names are in Table 1.

Species	wt	tr	bl	bd	bw	hb	wl	ta	tl
Banded bay cuckoo	30.0	17.3	17.4	5.8	4.6	43.1	104.0	97.8	200.0
Blue-eared barbet	32.0	19.3	16.6	8.4	8.5	41.0	77.0	44.4	164.0
Brown barbet	44.0	21.3	20.1 ±	12.4 ±	10.9 ±	48.1 ±	84.3 ±	60.5 ±	169.7
	± 5.6	± 2.0	0.8	1.1	2.2	1.4	0.6	1.6	± 15.9
Yellow-crowned barbet	48.0	21.7	23.2	10.9	11.4	52.7	95.0	64.8	215.0
Lesser cuckoo-shrike	28.0	21.4	14.6	5.2	5.5	41.4	72.0	69.7	178.0
Crow-billed drongo	60.5	21.8 ±	25.0 ±	10.9 ±	10.7 ±	57.2 ±	135.0	131.5	289.0
	± 2.1	0.5	0.1	0.3	1.0	1.0	± 7.1	± 23.3	± 26.9
Rufous-tailed tailorbird	10.0	17.7	10.4	3.5	2.7	29.2	55.0	48.8	121.0
Plain sunbird	10.0	14.7	14.5	2.2	2.7	32.2	61.0	48.3	130.0
Ruby-cheeked sunbird	9.0	16.3	12.3	3.5	2.9	29.1	55.0	40.4	110.0
Little spiderhunter	13.0	16.5 ±	36.7 ±	3.4 ±	3.7 ±	56.2 ±	68.0 ±	40.8 ±	161.5
	± 2.8	0.2	1.8	0.6	0.6	4.4	9.9	2.4	± 16.3
Grey-breasted spiderhunter	28.0	21.2	39.4	5.3	6.9	64.9	94.0	66.6	215.0

Table 3. Mean and standard deviation of external morphological measurements of birds in Lambir Hills National Park. For abbreviations of external morphological characters, see Table 2. Scientific names are in Table 1.

Species	wt	tr	bl	bd	bw	hb	wl	ta	tl
Brown barbet	37.8 ± 5.4	19.4 ± 1.7	19.7 ± 0.7	11.6 ± 0.5	9.1 ± 1.4	45.1 ± 1.1	78.2 ± 2.2	55.5 ± 6.7	159.8 ± 5.4
Red-throated barbet	79.0	26.2	35.8	13.9	13.9	67.7	100.0	55.5	205.0
Dusky broadbill	123.0	27.5	19.1	14.5	22.4	55.6	124.0	97.0	253.0
Malaysian honeyguide	36.0	13.4	10.1	5.4	5.9	33.5	91.0	59.7	159.0
Lesser green leafbird	22.5 ± 0.7	18.2 ± 0.1	12.5 ± 0.3	5.0 ± 0.1	4.8 ± 0.1	36.2 ± 0.9	75.0 ± 0.0	62.8 ± 4.3	160.0 ± 0.0
Grey-bellied bulbul	19.0	15.6	9.6	3.5	4.2	30.5	76.0	61.5	148.0
Puff-backed bulbul	23.0	19.5	14.5	5.6	5.0	40.7	93.0	92.0	203.0
Cream-vented bulbul	20.5 ± 0.7	17.6 ± 0.4	13.9 ± 1.1	4.9 ± 0.2	5.6 ± 0.4	38.4 ± 1.3	83.0 ± 1.4	74.4 ± 0.4	174.0 ± 1.4
Spectacled bulbul	18.0	17.4	10.2	3.9	5.2	31.7	74.0	64.9	155.0
Streaked bulbul	37.0 ± 1.5	20.0 ± 1.1	17.1 ± 1.8	6.4 ± 0.2	5.2 ± 0.4	45.9 ± 1.7	101.5 ± 6.1	95.5 ± 4.8	216.0 ± 8.7
Hairy-backed bulbul	11.5 ± 0.7	15.5 ± 0.0	11.5 ± 0.8	3.9 ± 0.1	4.2 ± 0.0	32.6 ± 1.0	69.0 ± 1.4	63.0 ± 2.9	143.0 ± 4.2
Pale blue flycatcher	14.0	19.4	9.8	4.0	3.7	31.6	64.0	51.5	130.0
Ruby-cheeked sunbird	8.0	16.5	11.9	3.1	3.4	28.9	55.0	36.3	100.0
Little spiderhunter	10.0	15.7	33.1	3.6	4.2	52.5	64.0	42.9	140.0
Thick-billed spiderhunter	11.5	15.1	28.6	4.3	5.0	46.0	64.0	38.0	130.0

Table 4. Means and standard deviations of external morphological measurements of birds in Taman Negara National Park. For abbreviations of external morphological characters, see Table 2. Scientific names are in Table 1.

Species	wt	tr	bl	bd	bw	hb	wl	ta	tl
Buff-rumped woodpecker	39.0	17.8	17.1	6.7	7.3	41.5	102.0	49.5	150
Banded broadbill	83.0	25.2	24.6	11.5	19.3	57.0	105.0	63.0	196.0
Green broadbill	58.5 ± 4.1	21.5 ± 0.5	12.2 ± 0.4	6.6 ± 0.5	10.2 ± 1.1	43.9 ± 1.0	103.5 ± 2.1	52.4 ± 4.6	173.8 ± 3.5
Bar-winged flycatcher shrike	9.5 ± 0.7	13.1 ± 0.8	10.6 ± 0.2	3.9 ± 0.1	5.1 ± 0.6	31.2 ± 0.2	60.5 ± 0.7	55.0 ± 1.5	126.0 ± 1.4
Spectacled bulbul	17.0	17.0	11.1	3.6	4.8	31.5	74.0	69.1	155.0
Yellow-bellied bulbul	32.0	21.8	15.9	6.4	5.8	43.9	96.0	83.5	200.0
Asian fairy-bluebird	61.0	17.9	20.3	8.7	8.9	48.9	118.0	91.2	230.0
White-bellied yuhina	12.0	16.7	11.6	4.0	3.9	31.3	69.0	40.5	120.0
Artic warbler	9.5 ± 0.7	17.1 ± 0.7	9.9 ± 1.0	3.2 ± 0.3	4.3 ± 0.1	30.0 ± 1.2	61.0 ± 2.8	43.3 ± 7.0	115.5 ± 6.4
Black-browed reed-warbler	8.0	18.2	10.2	2.9	3.7	30.1	58.0	44.8	110.0
Purple-throated sunbird	14.0	14.2	13.4	2.4	3.0	27.7	46.0	29.4	98.0
Grey-breasted spiderhunter	16.0	17.0	31.9	4.1	5.3	54.9	75.0	46.6	150.0
Crimson-breasted flowerpecker	6.0	12.8	10.0	4.0	4.0	25.4	49.0	25.7	82.0

Table 5. Comparison of family of birds captured in the canopy nets, ground nets and casual observation of the three study sites. No ground nets were deployed at Lambir Hills National Park. PHS = Poring Hot Spring, LHNP = Lambir Hills National Park, TNNP = Taman Negara National Park. (✓) = present.

Family	Canopy Nets			Ground Nets			Casual Observation		
	PHS	LHNP	TNNP	PHS	TNNP	PHS	LHNP	TNNP	
Cuculidae	✓	—	—	—	✓	✓	—	✓	
Meropidae	—	—	—	—	—	—	—	✓	
Alcedinidae	—	—	—	✓	✓	—	—	✓	
Bucerotidae	—	—	—	—	—	—	✓	✓	
Capitonidae	✓	✓	—	—	—	—	✓	—	
Picidae	—	—	—	✓	✓	—	—	—	
Eurylaimidae	—	✓	✓	—	✓	—	✓	✓	
Campephagidae	✓	—	—	—	—	✓	—	✓	
Chloropseidae	—	✓	—	—	✓	—	—	✓	
Pycnonotidae	—	✓	✓	✓	✓	✓	—	✓	
Dicruridae	✓	—	—	—	—	—	—	✓	
Oriolidae	—	—	✓	—	—	—	✓	✓	
Corvidae	—	—	—	—	—	—	✓	—	
Timaliidae	—	—	—	✓	✓	—	—	✓	
Turdidae	—	—	—	✓	✓	—	—	✓	
Sylviidae	—	✓	✓	✓	✓	—	—	✓	
Muscicapidae	✓	—	—	✓	✓	—	—	—	
Sturnidae	—	—	—	—	—	—	—	✓	
Nectariniidae	✓	✓	✓	✓	✓	—	—	✓	
Dicaeidae	—	—	✓	—	✓	—	—	✓	

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