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Bird Species Richness along an Elevational Gradient in a Forest at Jianfengling, Hainan Island, China

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Fa-Sheng Zou, Gui-Zhu Chen, Qiong-Fang Yang, and Yi-De Li (2012) Bird species richness along an elevational gradient in a forest at Jianfengling, Hainan Island, China. *Zoological Studies* **51**(3): 362-371. The avian communities of Hainan I., China are poorly known and under considerable threat. In our studies at Jianfengling, Hainan I. between May 2000 and Sept. 2004, 117 bird species were recorded using fixed-radius point counts and mist-netting at 3 elevations (200, 500, and 1000 m). Numbers of bird species recorded at the 3 elevations were 67 (200 m), 67 (500 m), and 89 (1000 m), of which 15 species were recorded exclusively at 200 m, 11 at 500 m, and 24 at 1000 m. The highest bird species richness occurred at the highest elevation (1000 m). The pattern of bird species richness differed from those of continental China and the island of Taiwan. Each elevation hosted a unique assemblage of special conservation concern. Species which require mature, full-canopy forest, and are often associated with mixed-species flocks were mainly distributed at 1000 m. The remnant forest at this elevation is clearly of high conservation importance. Illegal logging and hunting continue mainly at lower elevations (200 and 500 m). Frugivores, notably the pigeons *Ducula* spp. and *Treron* spp., are among bird species targeted by illegal hunters. We recommend that the Hainan Jianfengling National Nature Reserve be expanded to include this area of semi-deciduous monsoon forest at 200 m. Other coherent management strategies are training staff, increasing public awareness, providing incentives for conservation, and implementing conservation guidelines. http://zoolstud.sinica.edu.tw/Journals/51.3/362.pdf

Key words: Bird community, Conservation, Elevation gradient, Hainan Island.

Understanding spatial patterns in biodiversity along environmental gradients is a central theme in ecology. Explaining differences in species compositional turnover among sites occurring along gradients is crucial to understanding variations in the processes structuring communities (Kraft et al. 2011). More than 100 hypotheses have so far been proposed to explain large-scale spatial variations in species richness (Palmer 1994). Elevational gradients distributed across the globe are a powerful test system for understanding biodiversity (McCain 2009). Species diversity and community compositions of birds change rapidly along elevational gradients, particularly in tropical and subtropical regions (Terborgh 1977, Wu et al. 2010). The effect of elevation on variations in avian communities differs among regions. For example, bird species richness usually declines with elevation on Halmahera I. in Indonesia, while it increases below 900 m and declines above 900 m on Indonesia's Buru I. (Poulsen 2000). Bird species richness shows a hump-shaped relationship with elevation in Taiwan, increasing with elevation from sea level to a peak around 2000 m and then decreasing above that elevation (Lee et al. 2004). Usually, hump-shaped and decreasing patterns

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respectively account for about 50% and 25% of all cases of bird richness distribution along elevation gradients (McCain 2005, Rahbek 2005). Our understanding of the relation between elevation and species richness still appears to be immature, and some issues such as why humid mountains show mid-elevational peaks in diversity remain unresolved (Rahbek 1995, McCain 2009).

Hainan I. is one of only 2 regions with tropical forest in China. It is considered a global biodiversity hotspot (Myers et al. 2000). To date, 361 bird species including 2 endemic species and 47 endemic subspecies have been recorded on the island (Shi 1998, Zheng 2005, Liang et al. 2006). Tropical forest cover of the island was seriously reduced before the 1990s. Zeng et al. (1997) reported that forest cover on Hainan I. dropped from 90% in the early 20th century to 35% in the 1950s, following an influx of immigrants and rapid economic development, and then to 8% by the 1990s. Deforestation and fragmentation have not stopped even to the present (Zhang et al. 2010). Large unbroken stands of forest are now rare on Hainan. Among globally endangered or vulnerable species, as listed by Zheng and Wang (1998) and BirdLife International (2009), which may have been impacted by forest loss of this scale are the White-eared Night Heron (*Gorsachius magnificus*), for which there is no record on Hainan after 1962, Hainan Hill Partridge (*Arborophila ardens*), Pale-capped Pigeon (*Columba punicea*), Fairy Pitta (*Pitta nympha*), and Hainan Leaf Warbler (*Phylloscopus hainanus*). Rather little is known about the forest bird communities of Hainan I., and there is an urgent need for this gap in knowledge to be filled, especially for conservation purposes. Two of the main objectives of the study were: to (1) describe bird-richness patterns along an elevational gradient on Hainan I.; (2) identify conservation measures based on elevation distribution characteristics.

MATERIALS AND METHODS

Study site

Hainan I. is located some 18 km off the southern coast of China. The Jianfengling Forest Area (JFA, 18°23'-18°52'N, 108°36'-109°05'E) is situated in southwestern Hainan, covers 600 km^2, and was identified as an Important Bird Area by BirdLife International (Chan et al. 2009). This region has a varied topography including sandy beaches, coastal plains, hills, and mountains, with the highest point, Jianfengling peak, reaching 1412 m. The JFA is very diverse botanically, with more than 2800 plant species recorded (Zeng et al. 1997). The main forest types include tropical semi-deciduous monsoon forest, tropical evergreen monsoon forest, tropical montane rainforest, and mossy forest on the mountain peak (Huang et al. 1986). The climate is characterized by tropical monsoons with a wet season from May to Oct. and a dry season from Nov. to Apr. The mean annual temperature is 24.5°C, with an annual rainfall of 1600-2600 mm.

Sampling sites were distributed across 3 elevations at the JFA (Fig. 1). (1) 200 m. The low-elevation sampling site (190-285 m) consisted primarily of tropical semi-deciduous monsoon forest. *Terminalia hainanensis*, *Dalbergia odorifera*, *Spondias pinnata*, and *Albizia procera* were common species. Understory tree species included *Phyllochlamys taxoides*, *Taxotrophis aquifolioides*, and *Erioglossum rubiginosum* (Huang 1985). (2) 500 m. The mid-elevation sampling site (482-555 m) consisted primarily of tropical evergreen monsoon forest. *Vatica mangachapoi* constituted 30%-50% of all

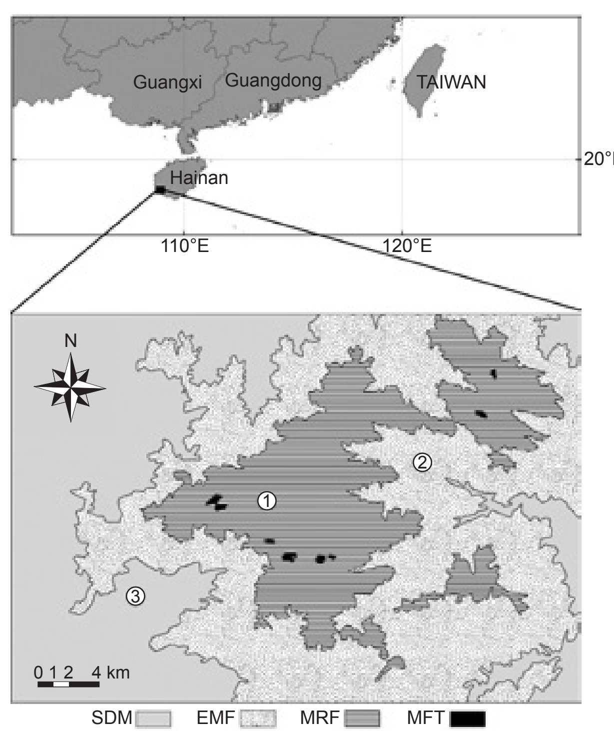

Fig. 1. Sample sites (SDM, semi-deciduous monsoon forest; EMF, evergreen monsoon forest; MRF, montane rainforest; MFT, mossy forest at the top of the mountain. Numbers 1, 2, and 3 represent sampling sites at the MRF, EMF, and SDM).

species; other common species were *Sindora glabra* and *Ormosia balansae*. The understory vegetation included *Diospyros longibracteata*, *Croton laevigatus*, and *Acronychia oligophlebia* (Huang 1985). (3) 1000 m. The high-elevation site (889-1025 m in elevation) was dominated by tropical montane rainforest, with 3 layers of vegetation. The 1st vegetation layer averaged 20-24 m in height and 30-50 cm in diameter at breast height (DBH). *Lithocarpus fenzelianus*, *Quercus bambusifolia*, *Schima superba*, *Madhuca hainanensis*, and *Dacrydium pierrei* were the common tree species. The 2nd layer averaged about 16 m in height and 15 cm in DBH; common tree species were *Cryptocarya chinensis*, *Syzygium araiocladum*, and *Gironniera subaequalis*. The 3rd layer averaged 8-10 m in height and 10 cm in DBH; tree species were similar to those of the 2nd layer, and the understory vegetation included *Calamus* spp., *Licuala spinosa*, and *Pinanga discolor* (Huang 1985).

Bird sampling

Birds were surveyed with a combination of fixed-radius (30 m) point counts and mist-netting because these 2 methods are known to complement each other in avifauna surveys (Blake and Loiselle 2000). Mist-nets measuring 12 m long, 2.6 m high, and with a 36-mm mesh were used to capture birds. Birds were sampled at the 3 elevations in 8 separate periods, four of which were in the wet season (May 2000, June 2001, Oct. 2001, and Sept. 2004) and 4 in the dry season (Nov. 2000, Feb. 2001, Jan. 2002, and Mar. 2002). The central position of each sampling site was recorded using a Global Positioning System (GPS, Garmin, Taiwan) (Table 1). Two connected mist nets were installed where vegetation and topography permitted, and all nets were situated in the forest interior. The greatest distance separating nets at the same sampling site was < 1150 m, and the smallest distance was 300 m (as measured by GPS). Ten nets were simultaneously deployed at each site except at 200 m. The same sampling sites were used throughout the study period. Nets were opened in good weather (no rain or strong wind) for 3 consecutive days from approximately 06:30 to 17:30, and were checked at hourly intervals. Time, location, species, and ring code (for recaptured birds) were recorded. Upon 1st capture, birds were banded using numbered aluminum leg-rings supplied by the National Bird Banding Center of China. After banding, all birds were immediately released at the capture site to minimize disruption of their normal movements.

At least 20 points were established along 3 preexisting trails for each habitat. All point count locations were measured by GPS, with the mean linear distance between points being 184.0 ± 6.5 m (*n* = 54). Each point was surveyed for a 10-min period initiated at 06:30-10:30. All birds detected visually or audibly within 30 m of the observer were recorded along with the estimated distance between birds and the observer, and the bird's activity height (Vergara et al. 2010, Zou et al. 2011). All point counts of each habitat were finished in 3 d with no strong wind or rain. Dominant species

Table 1. Numbers of species and individuals observed and captured

Category	200 m	500 m	1000 m
Coordinates			
Longitude	108°47'E	108°53'E	108°52'E
Latitude	18°42'N	18°47'N	18°44'N
Elevation range (m)	190-285	482-555	889-1025
Observed			
Total number of points	122	114	164
Number of species	65	61	80
Number of individuals	1301	1820	2337
Density (ind./ha)	12.3 ± 1.4 (*n* = 82)	21.0 ± 2.3 (*n* = 76)	20.3 ± 3.4 (*n* = 104)
Captured			
Mist-net hours	1051	1532	2320
Number of species	16	20	31
Number of individuals	118	141	189
Capture rate (ind./100 net hr)	10.8 ± 1.5 (*n* = 42)	9.7 ± 1.5 (*n* = 51)	8.1 ± 1.3 (*n* = 71)

ind., individuals.

were defined as those species that accounted for > 10% of the total number recorded or total captures (Zheng 1995). Abundance-based Chao-Jaccard's similarity estimators were used to compare both observed and captured species compositions among different habitats (Chao et al. 2005).

Statistical analysis

All data were examined for normality using Kolmogorov-Smirnov tests. A Kruskal-Wallis test was used to analyze differences in density and capture rates among elevations. Density calculations excluded those records based solely on sound. All statistical analyses were conducted with SPSS 16.0 (SPSS, Chicago, IL, USA). A rarefaction analysis was used to show species accumulation with EcoSim (Gotelli and Entsminger 2001). The nonparametric estimators of Chao 1 and Bootstrap were selected based on abundance distributions to estimate species using Estimate S version 7.5 (Colwell 2005). Data are presented as the mean ± standard error (SE) in the text and table 1.

RESULTS

In total, 117 species were recorded, of which 109 species were observed, and 39 species were captured. Of these, 78 species were only observed, and 8 species were only captured (Appendix). The Grey-cheeked Fulvetta (*Alcippe morrisonia*) was the dominant species accounting for 24% of the total number of individuals observed, and 38% of the total captured. Of the 117 species, 13 are listed in the *China Red Data Book of Endangered Animals*, they included 1 endangered species (Hainan Hill Partridge), 8 vulnerable species, and 4 rare species (Zheng and Wang 1998). Of the species of conservation concern, 9 were recorded at 200 m, 7 at 500 m and 8 at 1000 m.

Species richness was highest at 1000 m, where 89 species were recorded. The same number of species (67) was recorded at both 500 and 200 m (Appendix). Rarefaction curves showed sampling at 1000 and 500 m was more complete than at 200 m, and the 2 curves almost reached an asymptote (Fig. 2). Numbers of species estimated at 1000 m were 92 for Chao 1 and 91 for Bootstrap, very close to the actual number of species observed (Fig. 3). Numbers of species estimated at 500 m were 64 for Chao 1 and 70 for Bootstrap, also close to the actual number of species observed. At 200 m; however, a greater difference was found between the number of species estimated (75 for Chao 1 and 74 for Bootstrap) and species actually observed.

Frequency distributions of observation densities (Kolmogorov-Smirnov Z = 3.918, $n = 262$, $p = 0.001$) and captures (Kolmogorov-Smirnov Z = 2.412, $n = 164$, $p = 0.001$) were abnormally distributed. Mean observation-based densities of birds (individuals (ind.)/ha) by elevation were 12.3 ± 1.4 (at 200 m), 21.0 ± 2.3 (at 500 m), and 20.3 ± 3.4 (at 1000 m) (Table 1). There were a highly significant differences in observation-based densities among the 3 elevations ($H = 10.576$; $\chi^2_{0.05} = 5.99$, $n = 2$, $p = 0.005$). The density at 500 m was almost twice that recorded at 200 m.

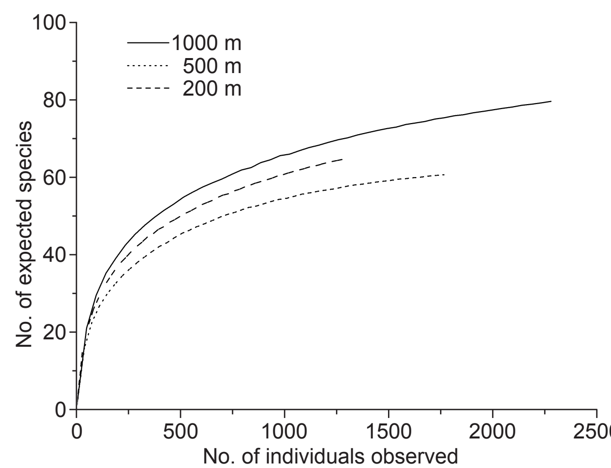

Fig. 2. Individual-based rarefaction curves for 3 elevations.

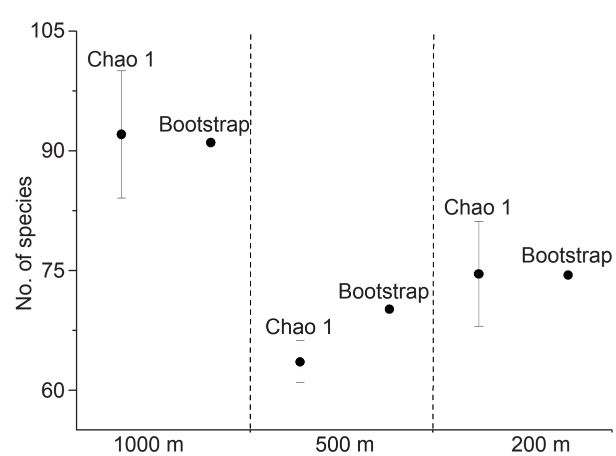

Fig. 3. Estimates of species richness from Chao 1 and Bootstrap for 3 elevations.

Mist-net capture rates (ind./100 net-h) by elevation were 10.8 ± 1.5 (at 200 m), 9.7 ± 1.5 (at 500 m), and 8.1 ± 1.3 (at 1000 m). Capture rates tended to decrease with increasing elevation, but not significantly ($H = 5.230$, $\chi^2_{0.05} = 5.99$, $n = 2$, $p = 0.073$).

The number of species recorded across all 3 elevations was 39 (33% of the species total), and numbers of species recorded exclusively at a single elevation were 15 (at 200 m), 11 (at 500 m), and 24 (at 1000 m). The highest similarity was between 1000 and 500 m (0.90), and the lowest similarity was between 1000 and 200 m (0.78) for observational data. Similarly, the highest similarity was between 1000 and 500 m (0.70), and the lowest similarity was between 1000 and 200 m (0.51) for capture data.

DISCUSSION

Bird richness patterns along an elevation gradient on Hainan Island

Describing and explaining spatial patterns of species diversity are crucial steps in conserving global biodiversity and are also long-standing research topics for biogeographers (Lee et al. 2004). Traditionally, bird species richness is expected to be inversely correlated with elevation, as higher mountains generally have smaller land areas, are more isolated, and have simpler vegetation structures (MacArthur 1972). Bird distribution patterns along elevational gradients in continental China exhibit the highest species richness at low and middle elevations, and decrease with increasing elevation. At Changbaishan (127°56'-128°6'E, 41°58'-42°6'N), the highest bird richness was at 600-1200 m (with an elevation range of 400 - > 2000 m) (Chen 1963). At Taibaishan (107°41'-107°51'E, 33°49'-34°8'N), the highest bird richness was at 500-1200 m (with an elevation range of 500-3767 m) (Yao and Zheng 1986), and at Emeishan (103°20'E, 29°31'N), the highest bird richness was at 600-1000 m (with an elevation range of 500-3500 m) (Cheng et al. 1963). At Yulongshan (100°10'E, 27°10'N), the highest bird richness was at 2400-3000 m (with an elevation range of 2400-5000 m) (Tan and Cheng 1964). In northern Taiwan off the southeastern Chinese coast; however, a different pattern of bird species richness was found, resembling an asymmetrical hump-shaped curve which slowly increases from low to mid elevations and decreases more quickly from mid to high elevations (Koh et al. 2006). In contrast to continental China and the island of Taiwan, bird species richness at the JFA on Hainan I. was greatest at 1000 m compared to the 2 other lower elevations studied. Factors including sampling, area effect, temperature, water, evolutionary history, human disturbances, and their combinations impact avian species richness distribution patterns (McCain 2009). A positive partial coefficient between bird species richness and temperature was observed in the Brazilian Cerrado (Diniz-Filho et al. 2008). As McCain (2009) pointed out, bird elevational diversity was positively and significantly related to temperature in most cases, although the strength of the relationship was highly variable. The relatively short span of elevational gradients of species richness was particularly sensitive to the effects of area and sampling regime (Rahbek 1995). Areas of the sampling sites at 200, 500, and 1000 m were 3706, 10,308, and 8902 ha, respectively (Li et al. 2002). Only 3 elevations were sampled in our study. It was not clear if area and temperature impacted species richness. Increased species richness at 1000 m is likely a product of higher foliage height, more-heterogeneous habitat, and complex topography in our study (Cheng et al. 1963, Terborgh 1971, Koh et al. 2006). Sites at approximately 1000 m exhibited the highest tree species richness, with numerous old and tall trees with large plank buttresses and a great variety of epiphytes, parasitic vines, and creepers (Huang 1985). A more-diverse physical and biotic habitat structure permits finer subdivision of limited resources and hence promotes greater specialization of species (Yao and Zheng 1986, Ding et al. 2006). Anthropogenic disturbances may have had negative effects on bird richness at lower elevations, because hunting and collecting firewood were sometimes encountered in our survey periods.

Conservation

In addition to supporting a greater diversity of carnivores and nectarivores than at other elevations (Appendix), the semi-deciduous monsoon forest at 200 m also accounted for 9 species in the *China Red Data Book of Endangered Animals* (Zheng and Wang 1998), and 15 species which were not found at other elevations, including Red Junglefowl (*Gallus gallus*), White-bellied Green Pigeon (*Treron sieboldii*), Large

Green-billed Malkoha (*Phaenicophaeus tristis*), Common Coucal (*Centropus sinensis*), Lesser Coucal (*Centropus bengalensis*), Scarlet-backed Flowerpecker (*Dicaeum cruentatum*), and Yellow-bellied Sunbird (*Nectarinia jugularis*). The biodiversity conservation of foothill forests has been overlooked (Peh et al. 2005, Wu et al. 2010). Lowland forests tend to be vulnerable to human disturbance from activities such as herding cattle, collecting firewood and medical herbs, and hunting. The foothill forest at 200 m at the JFA is not yet incorporated into the Hainan Jianfengling National Nature Reserve (Li et al. 2002). We recommend that the Hainan Jianfengling National Nature Reserve be extended to include this area of semi-deciduous monsoon forest at 200 m. This would entail further educational efforts and patrolling. In order to provide villagers with an alternative source of firewood, we also suggest active planting of species suitable for firewood near local villages.

The evergreen monsoon forest at 500 m, in which we recorded 67 species (11 species exclusively at this elevation), had the highest percentage of frugivores of the study (Appendix), including the Thick-billed Green Pigeon (*Treron curvirostra*). The Kadoorie Farm and Botanic Garden (2001) reported that frugivorous species, particularly pigeons, are rapidly declining or have disappeared from Hainan I., and attributed the declines to hunting and habitat loss. Demands of the local cuisine have put large and medium-sized forest birds such as pigeons under great hunting pressure. A few cases of hunting and live capture by local people were documented during our survey, highlighting the difficulties of enforcing bird protection in remote areas of forests such as at our study site. Illegal hunting can be addressed by a combination of increased patrolling by trained staff and educating local people on conservation issues.

Montane rainforest at 1000 m hosted the largest number of species (89) among the 3 elevations, including 24 exclusive species (Appendix). Of them, the Silver Pheasant (*Lophura nycthemera*) and Silver-breasted Broadbill (*Serilophus lunatus*) are national key protected species (MacKinnon et al. 2000). Montane rainforest at 1000 m also supported the highest percentage of insectivores (Appendix), including such species as the Large Yellow-naped Woodpecker (*Picus flavinucha*), Lesser Yellow-naped Woodpecker (*Picus chlorolophus*), Yellow-breasted Green Magpie (*Cissa hypoleuca*), and Yellow-billed Nuthatch (*Sitta solangiae*), all of which appear to require mature, full-canopy forest and are also dependent upon mixed-species flocks (Zou et al. 2011). Insectivores are particularly sensitive and vulnerable to deforestation (Stouffer and Bierregaad 1995, Burke and Nol 1998, Zannette 2000). These species and the forest that supports them now clearly merit increased conservation concern because of the rarity of forests of this quality following severe deforestation in the past several decades (Zeng et al. 1997, Zhang et al. 2010). It should be a key management strategy to ensure that existing blocks of montane forest at the JFA are protected from logging, disturbance, and inappropriate tourist infrastructure.

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APPENDIX. Individual percentages of birds at Jianfengling, Hainan I., China*

Common name	Scientific name	1000 m		500 m		200 m		DC**
		Cap.	Obs.	Cap.	Obs.	Cap.	Obs.	
Crested Serpent Eagle	*Spilornis cheela*	0	0.17	0	0.05	0	0.23	C
Eastern Marsh Harrier	*Circus spilonotus*	0	0	0	0	0	0.08	C
Shikra	*Accipiter badius*	0	0.17	0	0.33	0	0.31	C
Chinese Goshawk	*Accipiter soloensis*	0	0	0	0.11	0	0	C
Crested Goshawk	*Accipiter trivirgatus*	0	0.04	0	0	0	0.15	C
Besra Sparrow Hawk	*Accipiter virgatus*	0	0.09	0	0	0	0.08	C
Common Kestrel	*Falco tinnunculus*	0	0	0	0	0	0.08	C
Chinese Francolin	*Francolinus pintadeanus*	0	0.04	0	0	0	0.54	I/G
Hainan Hill Partridge	*Arborophila ardens*	0	0.04	0	0	0	0.15	O
Silver Pheasant	*Lophura nycthemera*	0	0.13	0	0	0	0	O
Red Junglefowl	*Gallus gallus*	0	0	0	0	0	0.77	O
Eurasian Woodcock	*Scolopax rusticola*	0	0.17	0	0	0	0	I
Emerald Dove	*Chalcophaps indica*	0.53	0	0.71	0	1.69	0	F
Thick-billed Green Pigeon	*Treron curvirostra*	0	0	0	0.11	0	0	F
White-bellied Green Pigeon	*Treron sieboldii*	0	0	0	0	0	0.08	F
Imperial Pigeon	*Ducula badia*	0	0.09	0	0.33	0	0	F
Large Hawk Cuckoo	*Cuculus sparverioides*	0	0.13	0	0.11	0	1.23	I
Indian Cuckoo	*Cuculus micropterus*	0	0.34	0	0.16	0	0.31	I
Oriental Cuckoo	*Cuculus saturatus*	0	0.04	0	0.05	0	0.08	I
Plaintive Cuckoo	*Cacomantis merulinus*	0	0.04	0	0.05	0	0.08	I
Large Green-billed Malkoha	*Phaenicophaeus tristis*	0	0	0	0	0	0.08	I
Common Coucal	*Centropus sinensis*	0	0	0	0	0	0.77	I
Lesser Coucal	*Centropus bengalensis*	0	0	0	0	0	0.08	I
Collared Scops Owl	*Otus bakkamoena*	0	0	0	0.11	0	0.23	C
Cuckoo Owl	*Glaucidium cuculoides*	1.59	0.09	2.13	0.22	0	0.46	I
Collared Pygmy Owl	*Glaucidium brodiei*	0	0.04	0	0.22	0	0.38	I
Large White-rumped Swift	*Apus pacificus*	0	0.09	0	0	0	0	I
Palm Swift	*Cypsiurus balasiensis*	0	0	0	0.11	0	0	I
Red-headed Trogon	*Harpactes erythrocephalus*	1.06	0.51	0	0.55	0	0	I
Blue-bearded Bee-eater	*Nyctyornis athertoni*	0	0.51	0	0.66	0	0.15	I
Black-browed Barbet	*Megalaima oorti*	0	1.80	1.42	2.25	0	1.77	F
Grey-headed Woodpecker	*Picus canus*	0	0	0	0.05	0	0.08	I
Grey-crowned Woodpecker	*Picoides canicapillus*	0	0.51	0	0.11	0	0	I
Rufous Woodpecker	*Celeus brachyurus*	0	0	0	0.16	0	0	I
Large Yellow-naped Woodpecker	*Picus flavinucha*	0	0.04	0	0	0	0	I
Lesser Yellow-naped Woodpecker	*Picus chlorolophus*	0	1.20	0	0	0	0	I
Yellow-billed Bay Woodpecker	*Blythipicus pyrrhotis*	0	0.21	0	0.22	0	0	I
Silver-breasted Broadbill	*Serilophus lunatus*	11.64	1.16	0	0	0	0	I
Blue-rumped Pitta	*Pitta soror*	0.53	0	0	0	0.85	0.23	I
Barn Swallow	*Hirundo rustica*	0	0.04	0	0.38	0	0	I
Yellow Wagtail	*Motacilla flava*	0	0.21	0	0.11	0	0.54	I
Gray Wagtail	*Motacilla cinerea*	0	0	0	0	0	0.08	I
White Wagtail	*Motacilla alba*	0	0	0	0.05	0	0	I
Olive-backed Pipit	*Anthus hodgsoni*	0	0.86	0	0	0	0	I/G
Grey-chinned Minivet	*Pericrocotus solaris*	0	6.12	0	2.14	0	0.77	I/F
Scarlet Minivet	*Pericrocotus flammeus*	0	7.10	0	2.47	0	0.15	I
Chinese Bulbul	*Pycnonotus sinensis*	0	0.43	0	2.31	0	3.54	O
White-throated Bulbul	*Alophoixus pallidus*	7.41	5.69	10.64	8.79	0.85	3.00	F
Green-winged Bulbul	*Hypsipetes mcclellandii*	0	1.07	0	0	0	0	F
Chestnut Bulbul	*Hemixos castanonotus*	0.53	3.42	2.84	9.67	0	3.31	F
Black Bulbul	*Hypsipetes leucocephalus*	0	0.04	0	0	0	0	F
Orange-bellied Leafbird	*Chloropsis hardwickii*	0	0.34	0	0.44	0	0.15	I
Long-tailed Shrike	*Lanius schach*	0	0.13	0	0.11	0	0.54	I
Brown-tailed Wood Shrike	*Tephrodornis gularis*	0	0.73	0	2.58	0	0	I

APPENDIX. (continued)

Common name	Scientific name	1000 m		500 m		200 m		DC**
		Cap.	Obs.	Cap.	Obs.	Cap.	Obs.	
Black-naped Oriole	*Oriolus chinensis*	0	0	0	0.05	0	0	I
Black Drongo	*Dicrurus macrocercus*	0	0.26	0	0.11	0	0.15	I
Bronzed Drongo	*Dicrurus aeneus*	1.59	1.58	1.42	1.48	0	0	I
Greater Racket-tailed Drongo	*Dicrurus paradiseus*	1.06	0.56	0	0.27	0	0	I
White-shouldered Starling	*Sturnia sinensis*	0	0.09	0	0	0	0	I/F
Yellow-breasted Green Magpie	*Cissa hypoleuca*	0.53	0	0	0	0	0	I
Red-billed Blue Magpie	*Urocissa erythrorhyncha*	0	0.17	0	2.31	0	0	O
Gray Treepie	*Dendrocitta formosae*	0	0.90	0	0.33	0.85	0.08	O
Ratchet-tailed Treepie	*Temnurus temnurus*	0	0.34	0	0	0	0	O
Japanese Robin	*Erithacus akahige*	0	0.04	0	0	0	0	I
Red-tailed Robin	*Luscinia sibilans*	1.59	0	1.42	0	0.85	0.08	I
Red-flanked Bush Robin	*Tarsiger cyanurus*	3.17	0.09	2.13	0	0	0	I
Magpie Robin	*Copsychus saularis*	0	0.04	0	0	0	0	I
White-runped Shama	*Copsychus malabaricus*	0	0	0	0	9.32	1.46	I
White-crowned Forktail	*Enicurus leschenaulti*	6.35	1.28	0.71	0.66	0	0.15	I
Stonechat	*Saxicola torquata*	0	0	0	0.27	0	0	I
Orange-headed Ground Thrush	*Zoothera citrina*	0.53	0	0	0	8.47	0	O
Siberian Ground Thrush	*Zoothera sibirica*	0	0.04	0	0	0	0	I
Golden Mountain Thrush	*Zoothera dauma*	1.06	0	0	0	0	0	I/F
Grey Thrush	*Turdus cardis*	0	0	2.13	0	0	0	I/F
Blackbird	*Turdus merula*	0	0.04	0	0	0	0.54	I/F
Pale Thrush	*Turdus pallidus*	0	0	0	0	0	0.08	I/F
Asian Brown Flycatcher	*Muscicapa dauurica*	0	0.09	0	0	0	0	I
Red-breasted Flycatcher	*Ficedula parva*	0	0.04	0	0	0	0	I
Blue-and-white Flycatcher	*Cyanoptila cyanomelana*	0	0	0.71	0	0	0	I
Hainan Blue Flycatcher	*Cyornis hainanus*	0	0.13	2.84	0.49	5.93	4.69	I
White-throated Fantail	*Rhipidura albicollis*	1.06	0.26	0.71	0.16	0.85	1.00	I
Black-naped Monarch	*Hypothymis azurea*	0	0.13	2.13	0.11	8.47	1.23	I
Lesser Necklaced Laughingthrush	*Garrulax monileger*	0.53	0.13	0	0	0	0	I
Greater Necklaced Laughingthrush	*Garrulax pectoralis*	1.59	0.47	0	0	0	0.54	O
Grey Laughingthrush	*Garrulax maesi*	0.53	2.70	0	0	0	4.23	I
Black-throated Laughingthrush	*Garrulax chinensis*	2.12	1.33	0	1.81	1.69	8.76	I/G
Hwamei	*Garrulax canorus*	0	0.04	0	0.22	0	1.23	I/G
Large Scimitar Babbler	*Pomatorhinus hypoleucos*	0.53	0.09	0	0	0	0.54	I
Rufous-necked Scimitar Babbler	*Pomatorhinus ruficollis*	6.35	3.25	9.93	3.35	0	4.00	I
Lesser Wren Babbler	*Napothera epilepidota*	1.59	0	0	0	0	0	I
Rufous-capped Babbler	*Stachyris ruficeps*	1.59	1.97	7.09	2.31	1.69	3.07	I
Spot-necked Babbler	*Stachyris striolata*	2.65	0.09	1.42	0	0	0	I
Red-winged Shrike Babbler	*Pteruthius flaviscapis*	0	0.47	0	0.44	0	0.08	I
Gould's Fulvetta	*Alcippe brunnea*	5.29	2.91	3.55	4.40	0	2.61	I/G
Grey-cheeked Fulvetta	*Alcippe morrisonia*	29.63	23.28	40.43	27.53	49.15	19.52	I
White-bellied Yuhina	*Erpornis zantholeuca*	1.06	8.52	5.67	7.80	7.63	5.61	I
Grey-headed Parrotbill	*Paradoxornis gularis*	5.29	3.94	0	1.10	0	0	I
Yellow-bellied Prinia	*Prinia flaviventris*	0	0.30	0	0.44	0	0.92	I/G
Pale-footed Bush Warbler	*Cettia pallidipes*	0	0	0	0	0	0.23	I
Common Tailorbird	*Orthotomus sutorius*	0	0	0	0	0	0.08	I
Dusky Warbler	*Phylloscopus fuscatus*	0	0	0	0	0.85	0.15	I
Yellow-browed Warbler	*Phylloscopus inornatus*	0	1.63	0	1.32	0	1.08	I
Greenish Warbler	*Phylloscopus trochiloides*	0	0	0	0.16	0	0	I
Blyth's Leaf Warbler	*Phylloscopus reguloides*	0.53	0	0	0	0	0	I
Pale-legged Leaf Warbler	*Phylloscopus tenellipes*	0.53	0	0	0	0.85	0.23	I
Hainan Leaf Warbler	*Phylloscopus hainanus*	0	3.21	0	0.16	0	0	I
Rufous-faced Warbler	*Abroscopus albogularis*	0	0.13	0	0	0	0	I
Japanese White-eye	*Zosterops japonicus*	0	0.86	0	2.69	0	10.61	I

APPENDIX. (continued)

Common name	Scientific name	1000 m		500 m		200 m		DC**
		Cap.	Obs.	Cap.	Obs.	Cap.	Obs.	
Great Tit	*Parus major*	0	0.04	0	0	0	0	I
Sultan Tit	*Melanochlora sultanea*	0	1.93	0	0.05	0	0	I
Yellow-billed Nuthatch	*Sitta solangiae*	0	1.11	0	0	0	0	I
Plain Flowerpecker	*Dicaeum concolor*	0	0.26	0	0.05	0	0	N
Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	0	0	0	0	0	0.15	N
Yellow-bellied Sunbird	*Cinnyris jugularis*	0	0	0	0	0	1.46	N
Fork-tailed Sunbird	*Aethopyga christinae*	0	1.11	0	3.63	0	4.84	N
White-rumped Munia	*Lonchura striata*	0	0.34	0	0.99	0	0.15	G
Spotted Munia	*Lonchura punctulata*	0	0	0	0.22	0	0	G

*Classification follows Zheng (2005). Cap., capture record; Obs., observation record. **DC, diet categories; C, carnivore; F, frugivore; G, granivore; I, insectivore; I/G, insectivore/granivore; I/F, insectivore/frugivore; N, nectarivore; O, omnivore based on Cheng and Tan (1973) and Xu et al. (1983).