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CHAPTER 3

AVIFAUNA OF THE GAOLIGONG SHAN MOUNTAINS OF WESTERN CHINA: A HOTSPOT OF AVIAN SPECIES DIVERSITY

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ABSTRACT.—The Gaoligong Shan Mountains (GLGS) of southwestern Yunnan, China, which form the southeastern extent of the Himalaya Mountains, are a narrow range running north–south, rising over 4,000 m in the north and receding into the lowlands in the south. The range is defined by the Irrawaddy lowlands to the west and by the Nujiang (also known as the Salween River) to the east. We summarize results of five recent ornithological expeditions that surveyed altitudinal transects in the southern and northern GLGS. The GLGS are a designated UNESCO World Heritage Site and are considered a "hotspot" by multiple conservation organizations. We used bird distributions to examine the hotspot status of the GLGS, and we discuss the value of the local species diversity for conservation. We found that the GLGS have tremendous avian diversity for a temperate region, with at least 486 documented avian taxa in the region. However, there is relatively little endemism in the GLGS per se, and ~50% of GLGS breeding bird species are near the edge of their range. Our data do not suggest that the GLGS are a major evolutionary center for birds; however, the larger eastern Himalaya region (of which the GLGS are a part), does appear to be a center of endemism and evolution. The GLGS may have been—and are likely to remain—an important and precious refuge for the preservation of Asian montane forest birds.

Key words: Asia, Hengduan Shan, Himalaya, survey, Yunnan.

Avifauna de las Montañas Gaoligong Shan del Oeste de China: Un Punto Caliente de Diversidad de Especies de Aves

RESUMEN.—Las montañas Gaoligong Shan (GLGS) del sudoeste de Yunnan, China, que forman la parte sudeste de las montañas Himalaya, son una cordillera estrecha que corre en sentido norte-sur y que alcanza más de 4,000 m en el norte y desciende hacia tierras bajas en el sur. La cordillera está definida por las tierras bajas de Irrawaddy al oeste y por Nujiang (también conocido como el río Salween) al este. Resumimos los resultados de cinco expediciones ornitológicas recientes que estudiaron transectas altitudinales en el sur y norte de las GLGS. Las GLGS están designadas por la UNESCO como Sitio de Patrimonio Mundial y son consideradas un "punto caliente" por varias organizaciones conservacionistas. Usamos la distribución de las aves para examinar el estatus de punto caliente de las GLGS y discutimos el valor de la diversidad local de especies para la conservación. Encontramos que las GLGS tienen una diversidad de aves enorme para una región templada, con al menos 486 taxones de aves documentados en

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la región. Sin embargo, hay relativamente pocos endemismos en las GLGS propiamente y ~50% de las especies de aves que crían en las GLGS están cerca del borde de su distribución. Nuestros datos no sugieren que las GLGS sean un centro principal de evolución de aves; sin embargo, la gran región este del Himalaya (de la cual las GLGS son parte) parece ser un centro de endemismo y evolución. Las GLGS pueden haber sido—y probablemente continúan siendo—un refugio importante y precioso para la preservación de las aves del bosque montano de Asia.

THE MOUNTAINS OF Southwest Yunnan, China, are among the most important biodiversity areas on the planet. They are recognized as a World Heritage Site (UNESCO, inscripted 2003) for holding the richest biodiversity of China and because they are likely the most biologically diverse temperate region on earth. These mountains lie within one of the top 10 conservation "hotspots" on the basis of species endemism and threat (Myers et al. 2000) as well as the total absolute number of species (Myers 1988, 1990; Ginsberg 1999). They are listed by Birdlife International as an important endemic bird area (Stattersfield et al. 1998).

The most remote and poorly known ranges in the mountains of Southwest Yunnan are the Gaoligong Shan (GLGS) of the Hengduan Shan (Chaplin 2005). These mountains run north–south, bordered on the east by the Nujiang (or Nu River, also known as the Salween River) and on the west by the Dulongjiang (or Dulong River, also known as the Irrawaddy River). The GLGS rise from the lowlands of Southeast Asia and comprise the front ranges of the eastern Himalayas, running nearly 500 km north along the China–Myanmar border. They receive high precipitation from the seasonal monsoon, and the climate varies from nearly tropical in the southern lower-elevation regions to glaciers in the northern higher-elevation regions. As such, the GLGS sit directly at the confluence of the Indo-Malay and Palearctic zoogeographic realms and include important floral and faunal components of both (Mayr 1938). The geology, climate, and evolutionary history are the most varied and diverse of the entire Hengduan Shan. See Chaplin (2005) for an excellent review of the complex geography of the GLGS.

Because birds are among the best-documented animal groups, ornithological data have helped drive conservation priority-setting (Myers 1990, Myers et al. 2000). Nonetheless, avian survey data for the GLGS are based on only a few expeditions that spent relatively little time in the area and focused primarily on the southern GLGS. Much of the relevant data come from historical collections from nearby, and mostly prior to the 1940s (see review below). Since then, little ornithological work has been done until recently. Most of the recent work was led by the Kunming Institute of Zoology (KIZ) in Kunming, Yunnan, and the Chinese Academy of Sciences (Yang et al. 1995, Xu 1998, Lan and Dunbar 2000, Yang and Yang 2004) and by collaborative rapid-assessment expeditions (Stotz et al. 2003). Furthermore, many changes have taken place in recent years—the area has developed tremendously with an influx of immigrants, demand for natural resources has intensified, and good roads have promoted travel and commerce in the area (Lan and Dunbar 2000, Stotz et al. 2003, Chaplin 2005, Willson 2006).

Since 2002, the KIZ and the California Academy of Sciences (CAS) in San Francisco have undertaken a series of multi-taxon biodiversity inventories in the GLGS that have included bird and mammal taxa. The goal of the work is to document the current biodiversity of the GLGS with modern specimen collections in both the southern and northern sections of the range. Here, we summarize our findings of five seasons of avian surveys made throughout the GLGS. We review the history of ornithological exploration in the GLGS, put our work in a historical context, and summarize the current state of knowledge about the avifauna of the ranges.

Finally, we combine our data with those of all other published surveys to create a comprehensive list of GLGS avifauna. We examine these data to critically evaluate the potential role and value of the GLGS for bird conservation. In particular, the GLGS is considered a hotspot of avian diversity (Mittermeier et al. 1998, Myers et al. 2000, Myers 2003), and, if it is, we ask whether this is because the GLGS is a center of in situ evolution or because it lies at the confluence of three major avifaunas—Palearctic, Indo-Malayan, and Himalayan (Mayr 1938). Others have argued that hotspots of species richness are not always congruent with other conservation measures, including richness of endemic, rare, or threatened species (Williams et al. 1996, Stattersfield et al. 1998, Orme et al. 2005, Possingham and Wilson

2005, Lamoreux et al. 2006), and there are many additional reasons why an area might be valuable for conservation. For example, the GLGS contain some of the largest and most intact natural tracts of evergreen broadleaf forest, deciduous forest, and bamboo woodland in all of Southeast Asia. This makes the GLGS area valuable for protecting water-catchment areas, for carbon sequestration, and for generally meeting REDD goals (Reducing Emissions from Deforestation and Forest Degradation; Madeira 2008, van der Werf et al. 2009). The GLGS continue to hold significant biodiversity, even in areas affected by human impacts (Lan and Dunbar 2000). We finish by discussing the conservation value of the GLGS in light of a variety of possible measures (historical refugia, human population density, historical human impact, corridors for climate change, and current development activities or plans).

Methods

Study area.—The extent of the Gaoligong Shan mountains is described by Chaplin (2005). In brief, the GLGS are the southeastern ranges of the Hengduan Shan and form the dividing ranges for the Irrawaddy River drainage to the west and the Nujiang (Salween River) drainage to the east. The GLGS lie approximately along the northern Yunnan border with Myanmar and run ~500 km in length. Our surveys sampled three major regions (northern, middle, and southern) and sampled multiple elevations within each region. The regions are shown in Figure 1, and dots on the map correspond with sampling localities. Approximate sampling localities are listed in Table 1 along with dates that each area was visited. The core areas were visited in both spring and autumn, with the exception of Shibali, which was inaccessible during

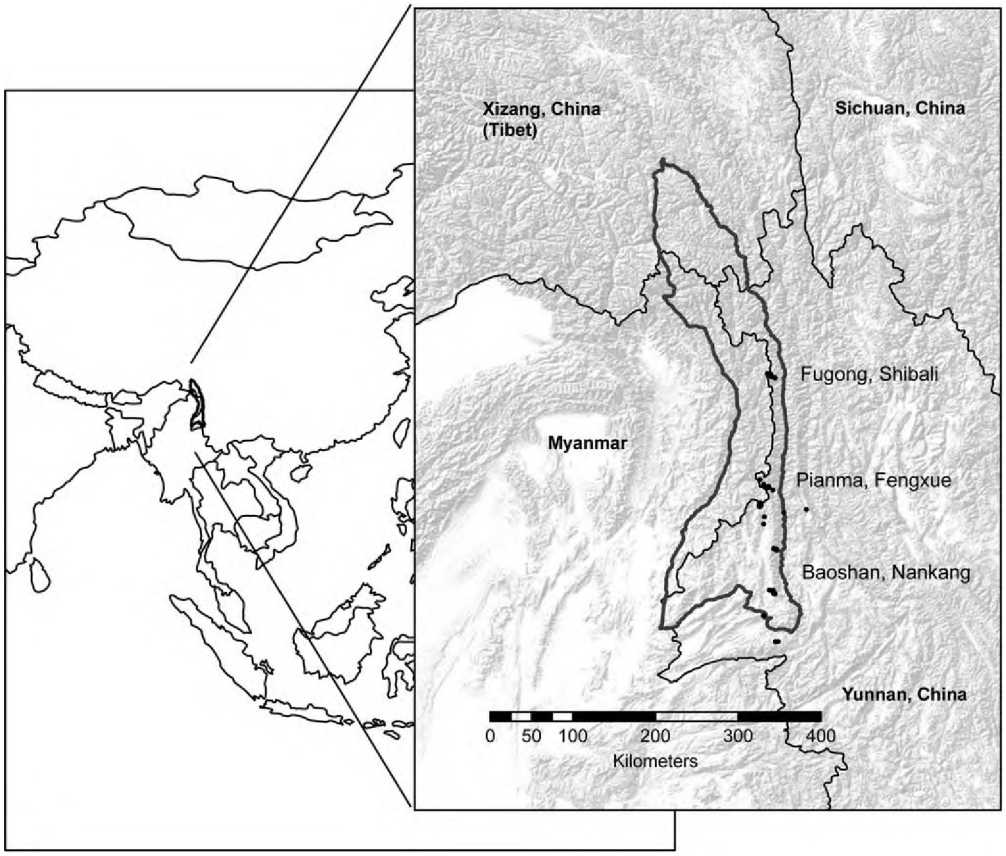

Fig. 1. Map of the Gaoligong Shan study area, Yunnan, China. The China–Myanmar border and Chinese provincial borders are outlined with thin black lines, and the Gaoligong Shan study area is outlined with a thick black line. Circles indicate collecting localities visited for this work.

TABLE 1. Collection dates and localities, sorted by latitude from north to south.

Collection dates	Locality name	Elevation (m)	Latitude	Longitude
4–6 October 2002	Liuku, Lushui County	802	25.703	98.874
11–16 October 2002	Shibali, Fugong County	2,560	27.166	98.780
24–31 October 2003	Zizhi, Tengchong County	2,525	25.786	98.627
2–4 November 2003	Xiao Di Fan, Tengchong County	2,141	24.857	98.759
2–4 November 2003	Zheng Ding, Tengchong County	2,210	24.830	98.766
5–6 November 2003	Nankan, Longyang County	2,125	24.820	98.779
7–12 November 2003	Bai Hua Ling, Longyang County	2,027	25.299	98.786
13–14 November 2003	Yun Shan, Long Ling County	1,614	25.579	98.658
2–26 April 2004	Pianma-Yaojiaping pass, Lushui County	2,100–3,200	25.973	98.683
20–29 October 2005	Pianma-Yaojiaping pass, Lushui County	2,100–3,200	25.973	98.683
1–8 November 2005	Shibali, Fugong County	2,560	27.166	98.780
10–18 November 2005	Pianma-Yaojiaping pass, Lushui County	2,100–3,200	25.973	98.683
12–19 April 2006	Zizhi, Tengchong County	2,525	25.786	98.627
20–23 April 2006	Zheng Ding, Tengchong County	2,210	24.830	98.766
24–26 April 2006	Nankan, Longyang County	2,125	24.820	98.779
28 April to 1 May 2006	Liang Shan, Long Ling County	2,457	24.297	98.782
4–11 May 2006	Bai Hua Ling, Longyang County	2,027	25.299	98.786

Spring 2004 because of deep snow in the high country and early rains in the low country.

Sampling methods.—Birds were surveyed primarily using mist nets. Nets varied in mesh size from 30 to 36 mm for sampling birds of different sizes, and nets varied in length from 6 to 12 m. Mist nets were strung between plastic poles along the ground or just off the ground. Nets were opened and tended from dawn to dusk. We prepared traditional museum specimens from representatives of each avian taxon captured from each location, and accompanying tissues were preserved in 100% ethanol. Basic measurement data were taken (mass, sex, skull ossification, wing length, total length, and soft-part colors) and are available upon request. Specimens were taken to the KIZ, where their identification was confirmed to species and subspecies using the existing KIZ collections. Potentially new taxa were compared with previously named taxa and considered for taxonomic revision. Specimens have been split between the KIZ in Yunnan and the CAS in California.

Additional field visual surveys were conducted along roads or pathways by multiple observers using binoculars, as time permitted. These visual surveys were performed to detect and record bird species that were difficult to net.

Taxonomy and species limits used for analyses follow Dickinson (2003). Results from earlier published surveys (Yang et al. 1995, Xu 1998, Lan and Dunbar 2000, Stotz et al. 2003) were combined with our list for some analyses or discussions, and taxonomy was updated accordingly to match Dickinson (2003). Recent research has suggested several changes to the taxonomy of Dickinson (2003), and we tried our best to update names if they had been vetted by taxonomic authorities and accepted. Thus, for recently published taxonomic revisions, we followed the more recent IOC World Bird List names (Gill and Wright 2006) and updates found online (www.worldbirdnames.org) as of April 2010.

We used data on species collected in the study area to estimate inventory completeness, endemism, and diversity. All but the most exhaustive inventories miss species. The difference between the number of species observed and the actual species richness can be assessed using a series of nonparametric estimators (Colwell and Coddington 1994, Gotelli and Colwell 2001, Herzog et al. 2002, Colwell 2006). Two different classes of biodiversity estimators were used: abundance-based and incidence-based. Both types of estimators are driven by rare species, although they differ in the way they count rarity. Abundance-based methods are driven by the total number of specimens in the collection, regardless of when or where they were collected. Species represented by a single individual are called "singletons," and those represented by two individuals are "doubletons." For incidence-based estimators, rarity is determined by the number of samples in which a species occurs, regardless of the actual number

of specimens. Species found in exactly one sample are called "uniques," and those found in two samples are "duplicates." The abundance-based estimators used in the present study are Chao 1 (Chao 1984) and the abundance-based coverage estimator (ACE; Chazdon et al. 1998), and the incidence-based estimators are Chao 2 (Chao 1987), the incidence-based coverage estimator (ICE; Chazdon et al. 1998), and the second-order jackknife (jackknife 2; Burnham and Overton 1978, 1979). All these methods use the proportion of species in a sequence of rare abundance classes to extrapolate to the zero abundance class, which is the estimated number of species overlooked by the survey. This plus the observed species richness is the estimated total number of species.

All bird specimens were identified to species and plotted in the geographic information system (GIS) software package ARCGIS, version 9.2. Incidence-based estimators require discrete samples, so the study area was divided *a posteriori* into 1-km^2 plots using the Fishnet tool in ARCVIEW. Specimens from the same plot were assigned to the same sample, and squares without any collections were ignored. Species-richness estimation curves were created over 100 randomized runs using ESTIMATES (Colwell 2006).

Beta diversity.—Sampling in the study area was not random but was concentrated in three core areas along the north–south mountain range. These were Shibali, Fengxue, and Nankang, arranged in decreasing elevation and latitude (Figs. 1 and 2 and Table 1). Approximately two-thirds of the specimens collected (1,162 identified specimens) came from these three core areas.

Using the identified and vouchered specimen data, we assessed the uniqueness of the bird fauna in each of these core areas using a modified version of Sørensen's (1948) classic index of community similarity (a measure of beta diversity). As with estimates of point (alpha) diversity, overlooked species can be a problem for beta diversity estimation. Genuinely shared species may be missed in the inventory of either site or both. Chao et al. (2005) have proposed a correction to Sørensen's (1948) index of community similarity. The Chao modification factors in estimated unobserved species shared between two communities. As with other such estimators, the correction is driven by rare species in one or both communities. Analysis was performed using ESTIMATES (Colwell 2006) with standard error calculated and multiplied by 1.96 to get the 95% confidence interval.

A complete list of GLGS birds.—In order to put our work in a historical framework and summarize what is known to date of the GLGS avifauna, we searched the Ornithological Information System (ORNIS; ornisnet.org) and Global Biodiversity Information Facility (GBIF; www.gbif.org) databases for specimens from western Yunnan and from northeastern Myanmar. We also examined publications that have resulted from major collections and from syntheses of the fauna of western Yunnan, and we summarize and cite those that contribute to our understanding of the GLGS (see below). We compiled all avian records and provide a working list of all species documented to occur in the GLGS (see Appendix). To standardize taxonomy, we used names recommended by the Howard and Moore checklist (Dickinson 2003).

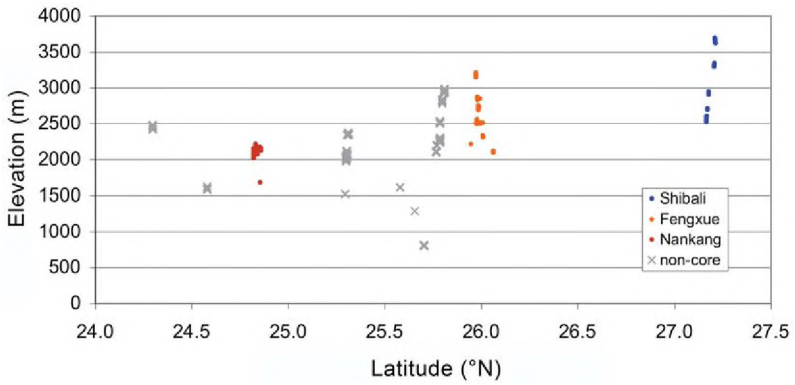

FIG. 2. Elevation versus latitude of sampling localities in the Gaoligong Shan study area, Yunnan, China. Note that the majority of effort was focused on the middle elevations (2,000–3,000 m above sea level), but these are spread throughout the three major latitudinal regions (north, middle, and south).

Conservation value.—Using this more complete list of birds of the GLGS, we discuss the value of the GLGS as a hotspot of species richness, as an area of regional endemism, and as a meeting and mixing place for multiple biotas. Biodiversity hotspots can arise because an area is a center for evolution, or because the area lies at the intersection of multiple zoogeographic regions (see below). We predicted that if a species evolved in the GLGS, the GLGS would be in the core of the species range. We additionally predicted that multiple limited-range species should have ranges centered at or near the GLGS.

To understand the origin and value of the avian biodiversity hotspot in the GLGS, we examined endemism and species ranges (both size and the relative location of the GLGS within each species range) using range information from ornithological publications (Cheng 1987, Mackinnon and Phillips 2000, Robson 2000, Dickinson 2003) for each bird species documented in the GLGS (see Appendix). For each species, we scored three characteristics of its range in relation to the GLGS. First, we characterized the species breeding range according to which zoogeographic regions were represented, using three relevant regions: Palearctic, Indo-Malay, and Himalayan (see Appendix). This was used to examine whether the overlap of zoogeographic regions plays a major role in increasing avian biodiversity. Second, we scored limited-range species as those species with estimated breeding ranges less than ~250,000 km^2. The GLGS study area was ~500 km from north to south, so 250,000 km^2 (equal to $[500\ km]^2$) included the restricted-range species of BirdLife (Stattersfield et al. 1998) as well those with ranges large enough to encompass other nearby regions of the eastern Himalayas. This provided some estimate of endemism or near-endemism in the GLGS. Third, we scored whether the GLGS region occurred in the central core of the species range or at the periphery. This was estimated visually on the basis of published range maps (Cheng 1987, MacKinnon and Phillips 2000, Robson 2000). The GLGS region was scored as "edge" if the species range ended at or adjacent to the GLGS or if the edge of the range intersected the GLGS. Otherwise, the GLGS were considered to lie in the "core" of the species range. We realize that many of these species range maps are not precise estimates and are based on incomplete data, but these ranges represent some of the best compilations of data to date. This is meant to be a coarse estimate and could be used to consider whether the GLGS are in the core of the range or at its margin. Also, the center of a taxon's range is often likely to represent the evolutionary origin of the taxon. If a species has a limited range and has the GLGS in the center of its range, this may indicate that the GLGS has been an evolutionary center for the taxon. There are certainly other important conservation considerations, and we discuss several of these in the discussion.

Results

Field results.—Approximate geographic locations and sampling dates for our expeditions are provided in Table 1 and are shown on the map in Figure 1. Within each latitudinal region, we attempted to survey a variety of elevations and habitats. Figure 2 shows the elevation of collecting localities plotted against latitude and clearly shows that elevation transect data are available for each general region.

Collections were made on a total of 104 calendar dates, and visual surveys were made on 38 dates. During our field work we collected 1,732 bird specimens from 166 species from throughout the GLGS. None of our collected specimens appeared to be new species; each specimen was identifiable to an existing taxon. Including birds documented by visual surveys, we recorded a total of 205 bird species in the GLGS region.

Several species were very common and were collected throughout the region, resulting in many representatives in our collections. The 10 most common species we collected were each represented by >40 specimens; these included *Ficedula strophiata* (41 individuals), *Luscinia cyanura* (41), *Leiothrix lutea* (46), *F. hyperythra* (47), *Yuhina flavicollis* (54), *Alcippe castaneceps* (57), *Phylloscopus pulcher* (64), *A. vinipectus* (65), *Seicercus tephrocephalus* (72), and *A. morrisonia* (90). All but three of these species were collected on each of five field expeditions, in spring and autumn, and in each of the three core survey areas. The exceptions were *L. lutea*, *Y. flavicollis*, and *A. morrisonia*, which were collected on only four of five field expeditions. These 10 most common species represented approximately one-third of the entire collection.

By contrast, 56 species (27% of all species) were documented by a single specimen or observation. Over half of the species documented (118 of 205) were represented by five or fewer specimens

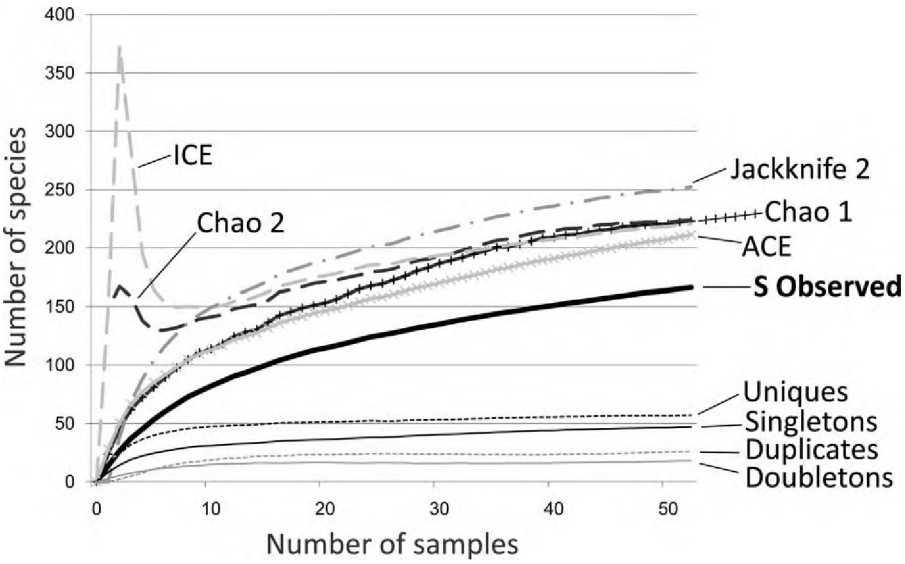

FIG. 3. Species-saturation curve and species-diversity estimators based on 1,732 collected bird specimens representing 166 observed species from the the Gaoligong Shan study area, Yunnan, China. The sampled diversity is shown in black ("S observed"), and other estimators are labeled. See text for detailed explanation of the estimators.

or observations throughout the duration of the study.

Species richness analyses.—We used specimen collection data for species richness analyses. Four of the estimators closely agreed that the actual number of species available to the inventory was between 211 and 224, and the second-order jackknife gave a higher estimate of 252 (Fig. 3). Thus, most of the estimators indicated that approximately three-quarters of the species present were collected during the inventory, and the jackknife estimator suggested that this was closer to two-thirds. Our observation data improve the documentation, given that 205 total species were observed (80–90% of species recorded); however, the analyses still indicate that more species are likely to be present in the area.

Other summaries indicated that as many as 350 species occur in the GLGS region (Xue et al. 1995), but many of these are species of lowlands or wetlands, where we did not sample. One rapid-assessment survey documented as many as 179 species (Stotz et al. 2003) using field observation alone, but these surveys collected no specimens that could be used for reference, genetic analyses, or to verify the identification of known taxa or new taxa.

Beta diversity.—Bird community composition follows a latitudinal gradient, with adjacent sites more similar than distant ones. Collections from the northern core area (Shibali) and the southern core area (Nankang) shared 33% and 37% species, respectively, with the central core area (Fengxue). Chao-Sørensen estimates that the actual overlap is much higher: 78% and 73%, respectively. The more distant northern and southern core areas shared 17% observed (51% estimated) species. The 95% confidence limits indicate that underlying communities in all three core areas are significantly different (Fig. 4).

GLGS summaries.—Combining our data with those of earlier studies, we compiled a total list of 486 avian taxa that have been documented in the region (Appendix). The greatest diversity has been documented in the southern GLGS (408 species), possibly because of its more tropical climate and greater variety of habitats. Two hundred and eighty-six species have been documented from the middle region (around Pianma, Feng Xue, to Liuku), and only 193 species in the north (FuGong, Shibali, and Dulong). The greatest survey effort to date has also taken place in the southern GLGS (Xue et al. 1995, Ma et al. 1996, Stotz et al. 2003), and the least in Shibali and Dulong Valley (Han and Yang 1996). Increased sampling effort will be important to document the remaining diversity in the northern regions; however, the data from our studies and previous studies suggest that species

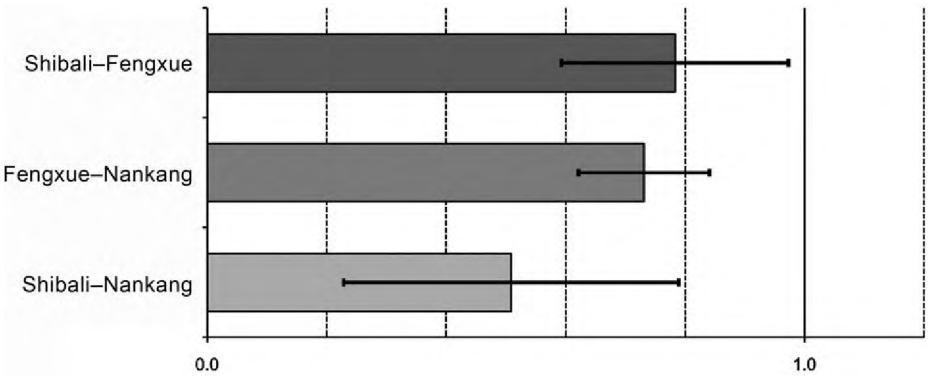

FIG. 4. Chao-Sørensen estimated community similarity and 95% confidence intervals with each core area compared to the others. Analysis based on collection data. On the x-axis, 0 = no overlap and 1 = identical. A confidence interval crossing the 1.0 mark indicates that communities are statistically indistinguishable.

diversity is greatest in the south and lesser in the north and that the differences are not merely an artifact of sampling effort.

Hotspot analyses.—For each species, we scored three characteristics of its range in relation to the GLGS. First, we characterized the breeding range according to which zoogeographic regions were represented, using three main regions: Palearctic, Indo-Malay, and Himalayan. Two hundred and sixty-five (of 486) species breeding ranges fell within only one zoogeographic region, 146 fell in two regions, and 75 spanned portions of all three regions. Table 2 shows the number of species in each region.

Second, we scored whether the GLGS region occurred in the central core of each species breeding range or at the periphery of the species range. Of the 486 species documented, the GLGS occurred in the center of the breeding range for 211 species, and near the edge of the range for 240 species (35 species were not expected to breed in the GLGS, and they were documented as migrants or winter residents). It is unclear what the expectation would be, but it is clear that nearly half (49.4%) of the species documented have the GLGS at the edge of their range, and 43.4 had the GLGS at the core of their range.

Third, we scored limited-range species as those with estimated breeding ranges less than ~250,000 km^2. This provided some estimate of endemism in the GLGS or nearby areas. We found that a total of 70 species (14.4%) are limited-range species by this definition. Most were found in other nearby areas (the Himalayas, other areas in the Hengduan Shan, or the mountains of northern Myanmar), and none was restricted to only the GLGS. This suggests that nearly 15% of GLGS species have limited species ranges, and for most of these, the GLGS represents a sizeable fraction of the entire species range.

TABLE 2. Numbers of birds with ranges in the Palearctic, Indo-Malay, and Himalayan biogeographic provinces.

Biogeographic province	Number of species
Palearctic (P)	87
Himalayan (H)	72
Indo-Malay (I)	106
H + I	56
P + I	46
P + H	44
P + H + I	75
All	486

DISCUSSION

Historical ornithology of the Gaoligong Shan.—There is a long history of ornithological work in the GLGS region, including the eastern Himalayan Mountains and the southern Hengduan Shan. Among the first published bird records of the region are John Anderson's explorations into western Yunnan via Myanmar. Anderson joined two expeditions to Yunnan in 1868 and 1875 that only barely penetrated the southernmost extent of the GLGS in the area around Tengyue (also known as Momien), in the Tengchong district of southwestern Yunnan (Anderson 1871a, b, 1878; Anderson and Sladen 1876). His team ran into

numerous difficulties, and his collections were relatively small, yet they recorded 115 bird species and reported high levels of biodiversity. Colonel George Rippon worked in the Kachin hills and the Shan States of Myanmar along the western slopes of the GLGS from 1897 to 1906 (Rippon 1901, 1904, 1905, 1906a, b, c), collecting >2,000 specimens and providing 26 new species descriptions for the British Museum. In 1912, Collingwood Ingram published a list of the birds of Yunnan province (Ingram 1912) summarizing the avifauna to date. The inspiration for Ingram's paper came from a large collection purchased by Lord Lionel Walter Rothschild from a "Japanese collector" but mostly collected in the southeastern corner of Yunnan, far away from the GLGS. A similar but smaller collection of 1,376 specimens was received from the same collector at Harvard University's Museum of Comparative Biology (Bangs and Phillips 1914), and several more species were added to the lists for Yunnan. One hundred and sixty-nine bird specimens were collected in 1908–1910 by M. Albert Pichon in the southern GLGS and sent to the National Museum of Natural History, Paris (Menegaux and Didier 1913). Roy Chapman Andrews led the Asiatic Zoological Expedition of the American Museum of Natural History from 1916 to 1917 (Andrews and Andrews 1918). They traveled through the southern GLGS near Long Ling, up the Nujiang valley, over the Nujiang-Shweli divide to Tengchong, and into Myanmar. The ornithological results were published by Outram Bangs (1921).

In the 1920s and 1930s, several important biologists surveyed and collected the flora and fauna of western Yunnan province. These include Joseph Rock, who was based in Lijiang, Yunnan, and worked in northwest Yunnan and nearby Tibet and Sichuan provinces. Rock was funded largely by the National Geographic Society, and most of his collections were deposited in the Smithsonian Institution in Washington, D.C., and were published by Riley (1926, 1930, 1931), but some were commissioned by and sent to other museums (Bangs and Peters 1928, Greenway 1933). Although most of the collections originated in the Hengduan Shan north or east of the GLGS, Rock surveyed some of the northernmost sections of the GLGS between the Nujiang and the Du Long River (Rock 1926), especially around Champutong (near modern-day Bingzhongluo). His collections were large and diverse and provide a good indication of the hill species found in the northern Hengduan Shan. The other large collections from the time were commissioned by Rothschild, who took a great interest in the birds of western Yunnan. Rothschild contracted the botanist and collector George Forrest to make several important collections (Rothschild 1921, 1923a, b, c; 1925). Forrest ventured throughout the GLGS during his many expeditions (see map in LeCroy and Dickinson 2001) spanning from 1904 to 1931. Rothschild later produced an important monograph summarizing the avifauna of Yunnan (Rothschild 1926), as well as several other shorter works (Rothschild 1927a, b, c).

From the western slopes of the GLGS, birds have been documented by several notable collections. Stanford and Ticehurst (Stanford and Ticehurst 1938a, b, c, d) reviewed the Myanmar work (including a small but important collection made by Kingdon-Ward and Lord Cranbrook in the Adung Valley; Kinnear 1934) and reported on additional collections made by Stanford in the mountains of northeastern Myanmar. Stanford returned to the Irrawady-Nujiang divide while on the Vernay-Cutting Expeditions (1938–1939), where the team worked in the central GLGS around Htawgaw, Pianma, and the nearby hills (Stanford and Mayr 1940, 1941a, b, c, d; Stanford 1946). Representing some of the most complete records up to their time, these papers summarize what was known to date of the avifauna of the western slopes of the GLGS.

After World War II and subsequent wars that affected the frontiers of China, ornithological exploration in the GLGS halted. More recently, ornithological work has flourished again, led by researchers primarily at the KIZ, as well as several conservation organizations. This work culminated in the two large volumes of *The Avifauna of Yunnan China* (Yang et al. 1995, Yang and Yang 2004), which stand as the most comprehensive summary and treatment of the birds of the province. This work is currently available only in Chinese. Other important summary articles have dealt with bird conservation status (Yang et al. 1988, Yang et al. 1996, Lan and Dunbar 2000, Yang et al. 2004), or surveys of protected areas (Xue et al. 1995, Han and Yang 1996, Ma et al. 1996, Stotz et al. 2003), and a thorough review of the birds of the larger Hengduan Shan, including the GLGS (Tang et al. 1996). These recent surveys have added several new species to the GLGS lists, and they have also pointed out several species that appear to be locally extinct or disappearing. This recent work has

produced sizable collections of Yunnan birds for the KIZ and has trained new generations of ornithologists in China's western provinces.

Our summary would not be complete without some mention of large expeditions or collections representing areas near the GLGS. Some of the earliest collections included those made by the Abbé Auguste Desgodins (stationed in southeastern Tibet), Père Armand David (in nearby Sichuan Province), and other early French missionaries (summarized by M. E. Oustalet). In 1895, Prince Henri d'Orleans (reported by Oustalet 1896, 1897a, b, 1898a, b, 1901) traveled from Vietnam to Assam up the Lancang Jiang (Mekong River), winding toward the Nujiang at various places in the south, but crossing the Lancang Jiang, Nujiang, and Irrawady rivers in the north to reach Assam. Over 200 specimens were collected, including many new species, but localities were not well documented. Furthermore, most of the collections were probably made east of the Lancang Jiang, and probably few, if any, were made in the GLGS area between the Nujiang and Irrawady rivers. A. W. S. Wingate collected >150 specimens from Southern Yunnan and Myanmar (Ogilvie-Grant 1900), passing just south of the GLGS.

In 1929, the William V. Kelley-Roosevelt Asiatic Expedition of the Field Museum of Natural History, Chicago (Bangs and Van Tyne 1930, 1931; Bangs 1932), collected 1,150 specimens from eastern Yunnan, Vietnam, and Laos, and team member Herbert Stevens continued collecting in northwest Yunnan and into Sichuan Province (Bangs 1932). The Dolan West China Expeditions of the Academy of Natural Sciences, Philadelphia, visited western Sichuan and northwestern Yunnan and collected 975 birds (Stone 1933). The team split, however, after completing the main expedition, and one group continued to collect as they traveled through western Yunnan and into Myanmar, and they added 233 specimens (some presumably birds) to the collection as they passed through the GLGS. The Sage West China expedition of the American Museum of Natural History collected 426 specimens from eastern Sichuan province (Birckhead 1937), and La Touche made significant collections in southeast Yunnan (La Touche 1923a, b, c, d).

Addition of our survey data.—Our collection of >1,732 specimens over five field seasons ranks among the largest collections made to date in western Yunnan. We additionally sampled areas as far north as Shibali in Fugong County, and as far south as Liang Shan, in Long Ling County, covering more area than many other surveys. The natural-history collections we produced will provide important benchmark data for the GLGS Nature Reserves, which are still relatively young.

Nonetheless, there are gaps in our sampling. Because our primary means of documenting species was using mist netting, we likely missed many species that are not easily netted, including larger species such as pheasants and partridges and species that live high in the canopy. Also, our habitat sampling was directed primarily at diurnal forest birds, and our surveys stayed relatively close to roads and established footpaths. We therefore were unable to survey patches of totally untouched forests, we spent little or no effort in wetland or lake regions, and we spent relatively little time and effort surveying nocturnal birds.

Our species richness analyses (Fig. 3) suggest that there are between about 211 and 252 bird species in the GLGS areas and habitats that we sampled, which is approximately what has been documented by us and others for the same habitats. Our work, combined with previous collections and surveys, documents a total of 486 species for all habitats in the GLGS (Xue et al. 1995, Stotz et al. 2003). Other publications have suggested estimates of up to 600 bird species for the entire GLGS (Stotz et al. 2003).

Our beta diversity analysis shows how rapidly bird community composition changes along a north–south axis in the Gaoligong Shan. Our three core areas are placed at approximately 100-km intervals. Over this relatively short distance, the percent estimated change in community composition is in the mid-twenties, with greater turnover at lower latitudes. This is consistent with a well-established pattern of latitudinal biodiversity gradients.

No undescribed species or subspecies were discovered in our surveys, although the material has been useful in the diagnosis of two new subspecies (one of which has been published; Renner et al. 2008). Although new species were not expected, undescribed species were recently discovered in nearby Myanmar in the GLGS foothills (Rappole et al. 2005). Furthermore, large tracts of forest remain relatively intact, and some areas are still isolated and difficult to reach. The Dulong Valley is one such area. Few expeditions have collected birds in the region (Han and Yang 1996), but the KIZ is actively supporting work there, and there should be new findings soon.

As these specimens are examined in greater detail, we expect to improve our understanding of the avifauna of the GLGS. Already, we have several important findings. Our specimen of *Brachypteryx stellata* (Gould's Shortwing), collected in fall 2005, is a new record for the KIZ Ornithology collection and possibly a range expansion for the species. Specimens of *Myzornis pyrrhoura* at CAS are the only representatives from China in any U.S. museum. A *Dicaeum melanoxanthum* (Yellow-bellied Flowerpecker) fledgling collected near the China–Myanmar border provides the first late-fall breeding date for this species. Currently, the breeding season of this species is unknown in the literature. Many of our collections will represent the first tissues in any North American collection. Together with other surveys and collections, 486 species have been documented from the GLGS (Appendix).

Analyses of avian biodiversity suggest a gradual clinal shift between the northern and southern GLGS areas. In support of this north–south faunal shift, there are five species represented by two subspecies, each distributed north–south within the GLGS: *Hirundo rustica gutturalis* and *H. r. tytleri*, *Cettia fortipes fortipes* and *C. f. davidiana*, *Liocichla phoenicea bakeri* and *L. p. ripponi*, *Pteruthius flaviscapis validrostris* and *P. f. yunnanensis*, *Alcippe castaneceps castaneceps* and *A. c. exul*. In every case, the subspecies split was oriented north–south, and not east–west. This is contrary to the typical pattern expected by vicariance. Vicariance alone might cause one to postulate that the GLGS ridgeline divides forms found in the Irrawady and Nujiang drainages, or that the Nujiang itself might isolate the GLGS from the other nearby ranges. But this is not the pattern that we see in our data. Instead, this north–south split may represent the different ecologies found in the warmer and more humid subtropical south versus the cooler climates of the higher mountain regions of the north. It may alternatively represent secondary contact zones for multiple taxa, but this too may have an ecological cause. (One additional species was represented by two subspecies, but these represented the overlap of wintering ranges with breeding ranges, or two subspecies sharing similar wintering ranges [*Anthus hodgsoni yunnanensis* and *A. h. hodgsoni*].)

Our colleagues at CAS, KIZ, and Kunming Institute of Botany studying other taxa find a similar faunal and floral shift north of Liuku and Fengxue. The southern GLGS has produced mostly widespread tropical and subtropical plant species and genera, whereas the areas north of Liuku, Fengxue, and Pianma have produced many new restricted-range species and even genera (Enroth and Ji 2006, Shevock et al. 2006, Long 2008). Although their data have not been completely analyzed yet, the amphibian fauna shifts between Liuku and Fugong (J. Wilkinson pers. comm.), as does the vascular flora (P. Fritsch pers. comm.) The causes of this biogeographic shift deserve additional research, and conservation planners should consider managing these areas independently.

Is the GLGS a center of endemism and evolution?—In recent publications on world conservation priorities, most of Southeast Asia is included in three major biodiversity hotspots—the Southwest China mountains hotspot, the Indo-Burma hotspot, and the Himalayas hotspot (Myers et al. 2000, Myers 2003). The GLGS lies almost exactly at the confluence of these hotspots. As mentioned earlier, the GLGS contains elements of all three avifaunas and, as such, is an especially diverse area in south-central Asia.

The Eastern Himalayas are a complex region composed of several mountain ranges separated by large, swift rivers. As a whole, the Eastern Himalayas are particularly rich in restricted-range species, but each component mountain range may have relatively few endemic forms. This appears to be true for the GLGS. Of the 22 restricted-range bird species of the eastern Himalayan endemic bird areas (Stattersfield et al. 1998), only 10 of these have been recorded from the GLGS, and none of these species are endemic to only the GLGS (i.e., all are found in neighboring mountain ranges). Only 4 of these 10 are considered threatened. The Indo-Burma hotspot (Myers et al. 2000) claims 140 endemic birds, but this hotspot includes all the Himalayan front ranges, and all of Burma, Laos, Vietnam, Cambodia, Thailand, and peninsular Malaysia. The GLGS contain some proportion of these Indo-Malay endemic species, but none are endemic to only the GLGS.

Although the GLGS region by itself is not an area of avian endemism, it hosts at least 70 species (14.4% of all species) that have limited ranges of ~250,000 km^2 or less. Although all are found in other areas as well (such as the Hengduan Shan, mountains of northern Burma, etc.), the GLGS provide a significant portion of the range for many of these species. In some cases, the GLGS may contain the only protected areas for the species.

Finally, for each avian taxon documented in the GLGS (486 total; Appendix), we scored whether the GLGS was situated at the edge of the species range or within the core. We estimated that 211 species (43.4%) had the GLGS within the core of the species breeding range and 240 (49.3%) had the GLGS at the edge of the range. This suggested that the high biodiversity of the GLGS may not simply be a trivial result of the intersection of three zoogeographic zones, but that the GLGS may be an important center for evolution as well as for conservation efforts.

Recent work by Johansson et al. (2007) suggested that the Himalayan ranges are species-rich because of immigration from outside forms, rather than because of in situ evolution. Our data and analyses are not powerful enough to test these hypotheses critically, and the GLGS region is a small enough area that it would not be expected to be a major source of in situ speciation. We hope that more studies will address the relative importance of immigration, endemism, and in situ evolution as data become available from the GLGS and as the taxonomy of Himalayan birds stabilizes.

Additional value of the GLGS to conservation.—In addition to being an area of exceptional biodiversity, the GLGS play other roles for avian conservation. The GLGS lie along the front ranges of the Himalayas, so there is an important meeting of lowland and upland faunas. There is a tremendous variety of habitats, diversity of latitude and elevation, and variation in slope and aspect. This variation can support and promote diversity in all flora and fauna, not just birds.

The GLGS lie in the core of many south-central Asian bird species ranges. Thus, these species are likely to be well adapted to the area (Kirkpatrick and Barton 1997) and are likely to survive and reproduce well. Furthermore, conservation efforts directed at the core are more likely to preserve greater genetic diversity for each species (Hoffman and Bouin 2004).

The north–south orientation of the GLGS ranges provides corridors and flyways for avian migration. These corridors are important for upland, ridge-following species as well as lowland, river-following species. Also, if global warming continues to increase, the north–south orientation of the mountains may facilitate the northward movement of species ranges better than other orientations, as upland species ranges may be able to shift northward along the GLGS ridge to track their preferred climate zone. More work needs to be done to model how climate change will affect this area.

Furthermore, the GLGS contain precious rare patches of intact forest. Already, as much as one-third of the area of the GLGS is devoted to agriculture, and human population density in the region is increasing rapidly (Ma et al. 1995, Ma et al. 1996, Lan and Dunbar 2000). Even when the early ornithologists reflected on their experiences in the mountains, they commented on the high population density and the extensive agricultural impacts. The greatest threats to birds include habitat destruction and degradation, and hunting and collecting by local people of live birds, pelts, and meat for sale in local markets. Although commercial logging has declined in Yunnan, there is still much local harvesting for firewood. Furthermore, commercial timber is being harvested from the western slopes of the GLGS in Myanmar at an alarming rate.

If one looks at the hotspot maps of southeast and south-central Asia (Conservation International), it appears as if much of the subcontinent is suggested for conservation. In reality, very little natural habitat remains, so high priority must be placed on those remaining tracts of pristine vegetation. BirdLife International has listed the GLGS areas as priority "urgent" (Stattersfield et al. 1998), the second-highest priority ranking. China has already established several important nature reserves in the GLGS, including the Three Parallel Rivers of Yunnan, UNESCO World Heritage Site (listed in 2003; ~1.7 million ha), and the Gaoligong Shan Nature Reserve (405,000 ha), and Myanmar has established Hkakabo Razi National Park (381,000 ha). The total area under nature-reserve designation in northern China west of the Nujiang is 3,776 km^2. This represents ~13% of the total area (Lan and Dunbar 2000). These protected areas will provide the main refuge for eastern Himalayan flora and fauna. These areas have critical biomass that is important for REDD strategies (Madeira 2008, van der Werf 2009) and for China's interests in protecting important water drainages and waterways.

In summary, we have documented 205 species occurring in the GLGS from our work, and a total of 486 species including all documented avian collections and visual surveys. Thus, the avian diversity in the GLGS represents 57.5% of bird species known to occur in Yunnan province (Yang et al. 1995, Yang and Yang 2004). The area owes its high diversity in part to the intersection

of three important zoogeographic zones, but the GLGS lie in the core of many birds' breeding ranges and are possibly a center for speciation. The GLGS region still has significant tracts of healthy forest representing a variety of habitats and climatic zones. The area is under significant pressure from local land use, and pressures are likely to increase with time and population growth. The biodiversity value of the GLGS is immense, and active conservation efforts are underway and will need to be maintained and increased to preserve the avian diversity and evolutionary potential of the region.

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APPENDIX. List of avian species documented in the Gaoligong Shan Mountains (GLGS) of southwestern Yunnan, China. Species documented in our 2002 to 2007 surveys are denoted by asterisks. Scientific and common names follow the Howard and Moore checklist (Dickinson 2003), with a few taxonomic changes (see Notes). "North GLGS" refers to the area from Fugong–Shibali north to Dulong Valley; "Middle GLGS" refers to the area approximately between Liuku, YaoJiaPing, Fung Xue Yakou, and Pianma; "South GLGS" refers to areas in Baoshan and Tengchong and farther south. Biogeographic provinces are Palearctic (P), Himalayan (H), or Indo-Malay (I). Each species was scored for whether the GLGS was located at the edge of the breeding range (E) or toward the center of the breeding range (C) or not in the breeding range (N; for example, for migrants). The GLGS was scored as "E" if the species range ended at or adjacent to the GLGS, or if the edge of the range shown intersected the GLGS. Otherwise, the GLGS was considered to lie in the "core" (or "C") of the species range. Limited range was considered to be ~250,000 km^2 or less, and scored as "Y" if the species range was smaller than this critical value. Resident status for each species was recorded as year-round resident (R), migrant (M), winter resident (W), summer breeder (S), possible migrant (M?), unknown (U), or vagrant (V). If a species has different resident status within different parts of the GLGS, both are recorded here. See text for explanation.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Chinese Francolin	*Francolinus pintadeanus*		X	X	I	E		R
Common Hill Partridge	*Arborophila torqueola*	X	X	X	H	E	Y	R
Rufous-throated Hill Partridge	*Arborophila rufogularis*			X	HI	E		M?
Green-legged Hill Partridge	*Arborophila chloropus*			X	I	E		R
Mountain Bamboo Partridge	*Bambusicola fytchii**		X	X	PI	C		R
Blood Pheasant	*Ithaginis cruentus*	X	X	X	PH	E		R
Satyr Tragopan	*Tragopan satyra*	X			H	E	Y	R
Blyth's Tragopan	*Tragopan blythii*	X			I	E	Y	R
Temminck's Tragopan	*Tragopan temminckii*	X	X	X	P	E		R
Sclater's Monal	*Lophophorus sclateri*	X	X	X	H	C	Y	R
Red Junglefowl	*Gallus gallus*			X	HI	E		R
Kalij Pheasant	*Lophura leucomelanos*	X			HI	E		R
Silver Pheasant	*Lophura nycthemera*		X	X	I	E		R
Mrs. Hume's Pheasant	*Syrmaticus humiae*	X	X	X	PI	C	Y	R
Common Pheasant	*Phasianus colchicus*		X	X	P	E		R
Lady Amherst's Pheasant	*Chrysolophus amherstiae**	X	X	X	P	E	Y	R
Gray Peacock-Pheasant	*Polyplectron bicalcaratum*			X	I	E		R
Green Peafowl	*Pavo muticus*		X		I	E		R
Bar-headed Goose	*Anser indicus*			X	P	E		M
Ruddy Shelduck	*Tadorna ferruginea*			X	P	E		W
Mallard	*Anas platyrhynchos*	X			P	N		W
Spot-billed Duck	*Anas poecilorhyncha*			X	PI	E		W
Northern Shoveler	*Anas clypeata*			X	P	N		W
Northern Pintail	*Anas acuta*			X	P	N		W
Common Teal	*Anas crecca*			X	P	N		W
Baer's Pochard	*Aythya baeri*			X	P	N		W

(*continued*)

APPENDIX. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Common Merganser	*Mergus merganser*			X	P	N		W
Little Grebe	*Tachybaptus ruficollis*			X	PI	C		R
Great Crested Grebe	*Podiceps cristatus*			X	P	E		W
Black Stork	*Ciconia nigra*	X		X	P	N		W
Schrenk's Bittern	*Ixobrychus eurhythmus*	X			P	E		S, W
Cinnamon Bittern	*Ixobrychus cinnamomeus*	X	X	X	PI	C		R
Black-crowned Night Heron	*Nycticorax nycticorax*			X	PI	C		R
Striated Heron	*Butorides striata*			X	PI	C		S
Chinese Pond Heron	*Ardeola bacchus*	X		X	PHI	E		R
Cattle Egret	*Bubulcus ibis*			X	PI	C		R
Little Egret	*Egretta garzetta*		X		PI	C		S
Little Cormorant	*Phalacrocorax niger*	X		X	I	E		W
Great Cormorant	*Phalacrocorax carbo*	X	X	X	PHI	E		R
Common Kestrel	*Falco tinnunculus*	X	X	X	PH	E		W
Eurasian Hobby	*Falco subbuteo*			X	PH	E		R
Oriental Honey Buzzard	*Pernis ptilorhynchus**	X	X	X	PI	C		S
Black-winged Kite	*Elanus caeruleus*			X	I	E		R
Black Kite	*Milvus migrans*	X		X	I	E		W, M
Brahminy Kite	*Haliastur indus*			X	I	E		R
Himalayan Griffon	*Gyps himalayensis*		X	X	H	E		W
Eurasian Griffon	*Gyps fulvus*			X	H	E	Y	M?
Red-headed Vulture	*Sarcogyps calvus*			X	I	E		R
Crested Serpent Eagle	*Spilornis cheela*		X		I	C		R
Hen Harrier	*Circus cyaneus*			X	P	N		W
Pied Harrier	*Circus melanoleucos*	X		X	P	N		W
Montagu's Harrier	*Circus pygargus*			X	P	N		M?
Crested Goshawk	*Accipiter trivirgatus**		X	X	HI	C		R
Shikra	*Accipiter badius*			X	I	E		R
Japanese Sparrowhawk	*Accipiter gularis*	X			P	N		S
Besra	*Accipiter virgatus**		X	X	PHI	C		R
Eurasian Sparrowhawk	*Accipiter nisus*	X	X	X	PH	E		W
Gray-faced Buzzard	*Butastur indicus*			X	P	N		M?
Eurasian Buzzard	*Buteo buteo*	X	X	X	P	N		W

(*continued*)

Appendix. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Indian Black Eagle	*Ictinaetus malayensis**	X	X	X	I	E		M?
Greater Spotted Eagle	*Aquila clanga*	X		X	P	N		M?
Golden Eagle	*Aquila chrysaetos*	X	X	X	PH	E		S
Bonelli's Eagle	*Hieraaetus fasciatus*			X	I	E		M?
Mountain Hawk-Eagle	*Spizaetus nipalensis*				HI	C		R
Slaty-breasted Rail	*Gallirallus striatus*			X	PI	E		S
White-breasted Waterhen	*Amaurornis phoenicurus*	X	X	X	PI	E		S
Ruddy-breasted Crake	*Porzana fusca*		X	X	PI	E		S
Watercock	*Gallicrex cinerea*			X	PI	C		S
Purple Swamphen	*Porphyrio porphyrio*			X	I	E		R
Common Crane	*Grus grus*			X	P	N		W
Yellow-legged Buttonquail	*Turnix tanki*			X	PI	C		R
Barred Buttonquail	*Turnix suscitator*			X	I	E		R
River Lapwing	*Vanellus duvaucelii*			X	I	E		R
Gray-headed Lapwing	*Vanellus cinereus*		X	X	P	N		W
Red-wattled Lapwing	*Vanellus indicus*			X	I	E		R
Pacific Golden Plover	*Pluvialis fulva*			X	P	C		W
Common Ringed Plover	*Charadrius hiaticula*			X	P	N		W
Greater Painted Snipe	*Rostratula benghalensis*			X	PI	C		W
Eurasian Woodcock	*Scolopax rusticola*	X	X	X	P	N		M
Black-tailed Godwit	*Limosa limosa*			X	P	N		M
Nordmann's Greenshank	*Tringa guttifer*			X	P	N		M?
Green Sandpiper	*Tringa ochropus*	X	X	X	P	N		W
Common Sandpiper	*Actitis hypoleucos**			X	P	N		W
Brown-headed Gull	*Larus brunnicephalus*	X			P	N		M
River Tern	*Sterna aurantia*			X	I	E		R
Rock Dove	*Columba livia*				PHI	E		U
Speckled Woodpigeon	*Columba hodgsonii*		X	X	H	C		R
Ashy Woodpigeon	*Columba pulchricollis*			X	H	C		R
Oriental Turtledove	*Streptopelia orientalis**	X	X	X	PHI	C		R

(*continued*)

APPENDIX. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Red Turtle Dove	*Streptopelia tranquebarica*	X	X	X	PI	C		S
Spotted-necked Dove (See Notes)	*Streptopelia chinensis*		X	X	PI	C		R
Barred Cuckoo-Dove	*Macropygia unchall*			X	I	E		R
Emerald Dove	*Chalcophaps indica*			X	I	E		R
Pin-tailed Green Pigeon	*Treron apicauda*			X	I	C		R
Wedge-tailed Green Pigeon	*Treron sphenurus*	X	X	X	HI	C		R
Mountain Imperial Pigeon	*Ducula badia*			X	I	E		R
Gray-headed Parakeet	*Psittacula finschii*	X	X	X	PI	C		R
Red-breasted Parakeet	*Psittacula alexandri*		X	X	I	E		R
Jacobin Cuckoo	*Clamator jacobinus*				HI	E		U
Chestnut-winged Cuckoo	*Clamator coromandus*			X	PHI	C		S
Large Hawk-cuckoo	*Cuculus sparverioides*	X	X	X	PHI	C		S
Common Cuckoo	*Cuculus canorus**	X	X	X	PHI	C		S
Himalayan Cuckoo	*Cuculus saturatus*		X	X	PH	C		S
Lesser Cuckoo	*Cuculus poliocephalus*	X	X	X	PHI	C		S
Plaintive Cuckoo	*Cacomantis merulinus*	X	X	X	PI	C		S
Asian Emerald Cuckoo	*Chrysococcyx maculatus*		X	X	PI	C		S
Asian Drongo Cuckoo	*Surniculus lugubris*		X	X	PI	C		R
Common Koel	*Eudynamys scolopaceus*		X	X	PI	C		S
Green-billed Malkoha	*Rhopodytes tristis**			X	I	E		R
Lesser Coucal	*Centropus bengalensis**			X	I	E		R
Grass Owl	*Tyto capensis*			X	I	E		M?
Collared Scops Owl	*Otus bakkamoena*		X	X	PI	C		R
Eurasian Scops Owl	*Otus scops*		X	X	P	N		R
Eurasian Eagle-Owl	*Bubo bubo*	X	X	X	PHI	E		R
Brown Fish Owl	*Ketupa zeylonensis*			X	I	E		R
Brown Wood Owl	*Strix leptogrammica*	X		X	I	E		R

(*continued*)

Appendix. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Tawny Owl	*Strix aluco*		X	X	PH	C		R
Collared Owlet	*Glaucidium brodiei**	X	X	X	PHI	C		R
Asian Barred Owlet	*Glaucidium cuculoides*		X	X	PHI	C		R
Brown Hawk Owl	*Ninox scutulata*			X	PI	C		R
Short-eared Owl	*Asio flammeus*			X	P	N		W
Great Eared Nightjar	*Eurostopodus macrotis*			X	I	E		R
Gray Nightjar	*Caprimulgus indicus*	X	X	X	PI	C		S
Large-tailed Nightjar	*Caprimulgus macrurus*			X	I	E		R
Himalayan Swiftlet	*Aerodramus brevirostris*	X		X	HI	C		R
White-throated Needletail	*Hirundapus caudacutus*	X	X		PH	C	Y	R
Asian Palm Swift	*Cypsiurus balasiensis*				I	E		R
Fork-tailed Swift	*Apus pacificus*	X	X		PHI	C		S
House Swift	*Apus affinis**	X	X	X	I	C		S
Orange-breasted Trogon	*Harpactes oreskios*			X	I	E		M?
Red-headed Trogon	*Harpactes erythrocephalus**		X	X	I	E		R
Ward's Trogon	*Harpactes wardi*	X		X	HI	E		R
Indian Roller	*Coracias benghalensis*		X	X	I	C		R
White-throated Kingfisher	*Halcyon smyrnensis*		X	X	I	C		R
Black-capped Kingfisher	*Halcyon pileata*	X	X	X	PI	C		R
Oriental Dwarf Kingfisher	*Ceyx erithaca*		X	X	I	E		R
Common Kingfisher	*Alcedo atthis**		X	X	PHI	C		R
Blyth's Kingfisher	*Alcedo hercules*			X	I	E		M?
Crested Kingfisher	*Megaceryle lugubris*		X		PHI	C		R
Pied Kingfisher	*Ceryle rudis*		X	X	I	E		R
Blue-bearded Bee-Eater	*Nyctyornis athertoni*			X	I	E		R
Green Bee-Eater	*Merops orientalis*		X	X	I	E		S
Blue-tailed Bee-Eater	*Merops philippinus*		X	X	I	E		S
Chestnut-headed Bee-Eater	*Merops leschenaulti*		X	X	HI	E		S
Common Hoopoe	*Upupa epops*	X	X	X	PHI	C		R
Oriental Pied Hornbill	*Anthracoceros albirostris*			X	I	E		R
Great Hornbill	*Buceros bicornis*			X	HI	E		R

(*continued*)

APPENDIX. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Rufous-necked Hornbill	*Aceros nipalensis*			X	I	E		R
Great Barbet	*Megalaima virens**	X	X	X	PHI	C		R
Lineated Barbet	*Megalaima lineata*				HI	E		R
Golden-throated Barbet	*Megalaima franklinii**	X	X	X	HI	C		R
Blue-throated Barbet	*Megalaima asiatica**		X	X	HI	E		R
Coppersmith Barbet	*Megalaima haemacephala*		X	X	HI	E		R
Northern Wryneck	*Jynx torquilla**	X	X	X	P	N		S
Speckled Piculet	*Picumnus innominatus**			X	PHI	C		R
White-browed Piculet	*Sasia ochracea*			X	I	E		R
Rufous-bellied Pied Woodpecker	*Hypopicus hyperythrus**			X	PHI	C		R
Gray-capped Pygmy Woodpecker	*Dendrocopos canicapillus*		X	X	PHI	C		R
Crimson-breasted Woodpecker	*Dendrocopos cathpharius tenebrosus*		X	X	PHI	C		R
Darjeeling Woodpecker	*Dendrocopos darjellensis**	X	X	X	H	C		R
Stripe-breasted Woodpecker	*Dendrocopos atratus*			X	I	E	Y	R
Crimson-breasted Woodpecker	*Dendrocopos cathpharius ludlowi*	X			PHI	C		R
Great Spotted Woodpecker	*Dendrocopos major**	X	X	X	P	E		R
Rufous Woodpecker	*Celeus brachyurus*			X	PI	C		R
White-bellied Woodpecker	*Dryocopus javensis*	X			I	E		R
Lesser Yellow-naped Woodpecker	*Picus chlorolophus*			X	HI	E		R
Greater Yellow-naped Woodpecker	*Picus flavinucha*			X	HI	C		R
Gray-headed Woodpecker	*Picus canus*		X	X	PHI	C		R
Bay Woodpecker	*Blythipicus pyrrhotis*		X	X	PHI	C		R
Great Slaty Woodpecker	*Mulleripicus pulverulentus*			X	HI	E		M?
Long-tailed Broadbill	*Psarisomus dalhousiae*		X	X	HI	E		R

(*continued*)

Appendix. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Rusty-naped Pitta	*Pitta oatesi*		X		I	E		R
Ashy Woodswallow	*Artamus fuscus*			X	I	E		R
Common Iora	*Aegithina tiphia*			X	I	E		R
Great Iora	*Aegithina lafresnayei*			X	I	E		M?
Large Cuckoo Shrike	*Coracina macei*		X	X	PHI	C		R
Black-winged Cuckoo-Shrike	*Coracina melaschistos*		X	X	PHI	C		R
Rosy Minivet	*Pericrocotus roseus*		X	X	PHI	C		S
Gray-chinned Minivet	*Pericrocotus solaris**		X	X	PHI	C		R
Long-tailed Minivet	*Pericrocotus ethologus*	X	X	X	PHI	C		S
Short-billed Minivet	*Pericrocotus brevirostris**	X	X	X	PHI	C		S
Scarlet Minivet	*Pericrocotus flammeus*		X	X	PHI	C		S
Bar-winged Flycatcher-Shrike	*Hemipus picatus*		X	X	PHI	C		R
Brown Shrike	*Lanius cristatus*	X	X	X	P	N		W
Burmese Shrike	*Lanius collurioides*		X	X	I	E		R
Long-tailed Shrike	*Lanius schach**		X	X	PHI	C		R
Gray-backed Shrike	*Lanius tephronotus**	X	X	X	PH	C		R
Slender-billed Oriole	*Oriolus tenuirostris*		X	X	I	E		R
Maroon Oriole	*Oriolus traillii*	X		X	HI	E		R
Black Drongo	*Dicrurus macrocercus**	X	X	X	PHI	C		S
Ashy Drongo	*Dicrurus leucophaeus**	X	X	X	PHI	C		S
Crow-Billed Drongo	*Dicrurus annectans*			X	I	E		S
Bronzed Drongo	*Dicrurus aeneus*			X	I	C		R
Lesser Racket-tailed Drongo	*Dicrurus remifer*			X	HI	E		S
Hair-crested Drongo	*Dicrurus hottentottus**	X		X	PHI	C		S
Greater Racket-tailed Drongo	*Dicrurus paradiseus*			X	I	E		S
Yellow-bellied Fantail	*Rhipidura hypoxantha**	X	X	X	HI	C		R
White-throated Fantail	*Rhipidura albicollis**	X	X	X	PHI	C		S
White-browed Fantail	*Rhipidura aureola*		X	X	I	E		S

(*continued*)

APPENDIX. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Yellow-billed Blue Magpie	*Urocissa flavirostris**	X	X	X	H	E		R
Red-billed Blue Magpie	*Urocissa erythrorhyncha**	X	X	X	PI	C		R
Common Green Magpie	*Cissa chinensis*		X	X	HI	E		R
Gray Treepie	*Dendrocitta formosae**		X	X	PHI	C		R
Common Magpie	*Pica pica*		X	X	PI	C		R
Eurasian Nutcracker	*Nucifraga caryocatactes*	X	X	X	PH	C		R
Large-billed Crow/Jungle Crow	*Corvus macrorhynchos*	X	X	X	PHI	C		R
Great Tit	*Parus major**	X	X	X	PHI	E		R
Green-backed Tit	*Parus monticolus**	X	X	X	H	C		R
Yellow-bellied Tit	*Parus venustulus*		X		P	E		M?
Yellow-cheeked Tit	*Parus spilonotus**	X	X	X	PHI	C		R
Rufous-vented Tit	*Parus rubidiventris**	X	X		H	E	Y	R
Gray-crested Tit	*Parus dichrous*	X			H	E	Y	R
Sultan Tit	*Melanochlora sultanea*			X	I	E		R
Yellow-browed Tit	*Sylviparus modestus**	X	X	X	H	E		R
Fire-capped Tit	*Cephalopyrus flammiceps*			X	H	E		R
Plain Martin	*Riparia paludicola*		X	X	I	E		R
Barn Swallow	*Hirundo rustica gutturalis*		X	X	P	C		S
Barn Swallow	*Hirundo rustica tytleri*	X			P	C		M?, S
Northern House Martin	*Delichon urbicum*			X	P	N		W
Nepal House Martin	*Delichon nipalense*		X		H	C		R
Red-rumped Swallow	*Cecropis daurica*		X	X	PHI	C		S
Striated Swallow	*Cecropis striolata*		X	X	I	E		S
Long-tailed Tit	*Aegithalos caudatus*			X	P	E		R
Black-throated Tit	*Aegithalos concinnus**	X	X	X	PH	C		R
Black-headed Tit	*Aegithalos bonvaloti**		X		H	E	Y	R
Greater Short-toed Lark	*Calandrella brachydactyla*			X	P	E		M
Oriental Skylark	*Alauda gulgula*		X	X	PHI	C		R
Fan-tailed Cisticola/ Zitting Cisticola	*Cisticola juncidis*			X	PI	C		S
Brown Prinia	*Prinia polychroa*		X	X	I	E		R

(*continued*)

Appendix. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Hill Prinia	*Prinia atrogularis**	X	X	X	I	C		R
Gray-breasted Prinia	*Prinia hodgsonii**		X	X	HI	C		S
Yellow-bellied Prinia	*Prinia flaviventris*			X	I	E		R
Plain Prinia	*Prinia inornata**	X	X	X	PI	E		R
Mountain Tailorbird	*Orthotomus cucullatus**		X	X	I	E		R
Common Tailorbird	*Orthotomus sutorius**			X	I	E		S
Crested Finchbill	*Spizixos canifrons**		X	X	PI	C		R
Striated Bulbul	*Pycnonotus striatus**	X	X	X	PHI	C	Y	R
Black-crested Bulbul	*Pycnonotus melanicterus*			X	HI	E		R
Red-whiskered Bulbul	*Pycnonotus jocosus**		X	X	HI	C		R
Brown-breasted Bulbul	*Pycnonotus xanthorrhous**	X	X	X	P	C		R
Red-vented Bulbul	*Pycnonotus cafer**		X	X	I	E		R
Sooty-headed Bulbul	*Pycnonotus aurigaster*				PI	E		R
Flavescent Bulbul	*Pycnonotus flavescens**			X	I	E		R
White-throated Bulbul	*Alophoixus flaveolus*		X	X	I	E		R
Puff-throated Bulbul	*Criniger pallidus*			X	I	E		R
Green-winged Bulbul	*Ixos mcclellandii**	X	X	X	PHI	C		R
Ashy Bulbul	*Hemixos flavala**			X	HI	C		R
Black Bulbul	*Hypsipetes leucocephalus (madagascariensis)**	X	X	X	pHI	C		R
Striated Grassbird	*Megalurus palustris*			X	I	E		R
Chestnut-headed Tesia	*Oligura castaneocornata**	X	X		H	C		R
Slaty-bellied Tesia	*Tesia olivea**	X	X	X	H	C		R
Gray-bellied Tesia	*Tesia cyaniventer**	X	X	X	H	C		R
Pale-footed Bush Warbler	*Cettia pallidipes*			X	H	E		M?
Brownish-flanked Bush Warbler	*Cettia fortipes fortipes*	X			PH	E		R
Brownish-flanked Bush Warbler	*Cettia fortipes davidiana*		X	X	PH	E		R
Chestnut-crowned Bush Warbler	*Cettia major**			X	H	E		S

(*continued*)

APPENDIX. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Aberrant Bush Warbler	*Cettia flavolivacea**			X	H	C		S
Brown Bush Warbler	*Bradypterus luteoventris*	X		X	PHI	C		S
Thick-billed Warbler	*Phragmaticola aedon*			X	P	N		M
Paddyfield Warbler	*Acrocephalus concinens*			X	P	N		M
Dusky Warbler	*Phylloscopus fuscatus**		X	X	P	N		M
Alpine Leaf Warbler	*Phylloscopus occisinensisa**			X	P	E		M?
Buff-throated Warbler	*Phylloscopus subaffinis**			X	P	E		S
Yellow-streaked Warbler	*Phylloscopus armandii**			X	P	E		S
Buff-barred Warbler	*Phylloscopus pulcher**	X			PH	C		S
Ashy-throated Warbler	*Phylloscopus maculipennis**	X	X	X	H	E		W
Sichuan Leaf-Warbler	*Phylloscopus forrestia**	X	X	X	P	N		W
Yellow-browed Warbler	*Phylloscopus inornatusa**		X	X	P	N		W
Arctic Warbler	*Phylloscopus borealis**		X	X	P	N		M
Large-billed Leaf Warbler	*Phylloscopus magnirostris**	X		X	H	E		S
Blyth's Leaf Warbler	*Phylloscopus reguloidesa**	X	X	X	HI	C		S
White-tailed Willow Warbler	*Phylloscopus davisoni**	X	X	X	HI	E		R
Yellow-vented Leaf Warbler	*Phylloscopus cantator*		X	X	I	E		S
Gray-crowned Warbler	*Seicercus tephrocephalus**	X	X	X	PHI	C		S
Gray-cheeked Warbler	*Seicercus poliogenys**	X			H	C		S, R
Chestnut-crowned Warbler	*Seicercus castaniceps**	X	X	X	PHI	C		S
Broad-billed Warbler	*Tickellia hodgsoni**				HI	E	Y	U
Black-faced Warbler	*Abroscopus schisticeps**		X	X	H	C	Y	R
Puff-throated Babbler	*Pellorneum ruficeps*		X	X	HI	E		R
Large Scimitar Babbler	*Pomatorhinus hypoleucos*			X	I	E		M?
Rusty-cheeked Scimitar Babbler	*Pomatorhinus erythrogenys*		X	X	HI	E		R

(*continued*)

Appendix. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Streak-breasted Scimitar Babbler	*Pomatorhinus ruficollis**	X	X	X	PH	C		R
Coral-billed Scimitar Babbler	*Pomatorhinus ferruginosus*				I	C	Y	R
Slender-billed Scimitar Babbler	*Xiphirhynchus superciliaris**	X		X	H	C	Y	R
Streaked Wren-Babbler	*Napothera brevicaudata*			X	I	E		M?
Eyebrowed Wren-Babbler	*Napothera epilepidota*				I	E		U
Scaly-breasted Wren-Babbler	*Pnoepyga albiventer**	X		X	H	E	Y	R
Pygmy Wren-Babbler	*Pnoepyga pusilla**		X	X	PHI	C		R
Bar-winged Wren-Babbler	*Spelaeornis troglodytoides*		X	X	P	E	Y	R
Long-tailed Wren-Babbler	*Spelaeornis chocolatinus**	X		X	PI	C	Y	R
Wedge-billed Wren-Babbler	*Sphenocichla humei*	X			I	C	Y	R
Buff-chested Babbler	*Stachyris ambigua*	X			H			R
Rufous-fronted Babbler	*Stachyris rufifrons*				HI	C		U
Rufous-capped Babbler	*Stachyris ruficeps**	X	X	X	PH	C		R
Golden Babbler	*Stachyris chrysaea**	X	X		I	C		R
Gray-throated Babbler	*Stachyris nigriceps**			X	HI	C		R
Chestnut-capped Babbler	*Timalia pileata*			X	I	E		R
Yellow-eyed Babbler	*Chrysomma sinense**		X	X	I	E		R
Chinese Babax	*Babax lanceolatus*		X	X	PI	C		R
White-throated Laughing-Thrush	*Garrulax albogularis*		X	X	PH	E		R
White-crested Laughing-Thrush	*Garrulax leucolophus*			X	HI	C		R
Lesser Necklaced Laughing-Thrush	*Garrulax monileger*			X	I	E		R
Greater Necklaced Laughing-Thrush	*Garrulax pectoralis*			X	PHI	E		R

(*continued*)

APPENDIX. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Striated Laughing-Thrush	*Garrulax striatus**	X	X	X	H	C	Y	R
Black-throated Laughing-Thrush	*Garrulax chinensis*			X	I	E		R
Moustached Laughing-Thrush	*Garrulax cineraceus*		X	X	P	C		R
Spotted Laughing-Thrush	*Garrulax ocellatus*	X	X		H	E		R
Gray-sided Laughing-Thrush	*Garrulax caerulatus*		X	X	H	E	Y	R
Rufous-necked Laughing-Thrush	*Garrulax ruficollis*			X	H	E	Y	R
Spot-breasted Laughing-Thrush	*Garrulax merulinus*		X	X	I	E	Y	R
Melodious Laughing-Thrush	*Garrulax canorus*		X	X	P	E		R
White-browed Laughing-Thrush	*Garrulax sannio**	X	X	X	PI	C		R
Blue-winged Laughing-Thrush	*Garrulax squamatus**	X		X	HI	E	Y	R
Scaly Laughing-Thrush	*Garrulax subunicolor**	X	X	X	H	C	Y	R
Black-faced Laughing-Thrush	*Garrulax affinis**	X	X	X	PH	C	Y	R
Chestnut-Crowned Laughing-Thrush	*Garrulax erythrocephalus**	X	X	X	H	C		R
Red-tailed Laughing-Thrush	*Garrulax milnei**		X	X	PI	E		R
Red-faced Liocichla	*Liocichla phoenicea bakeri*	X			H	C	Y	R
Red-faced Liocichla	*Liocichla phoenicea ripponi*			X	I	C	Y	R
Silver-eared Mesia	*Leiothrix argentauris**		X	X	PHI	C		R
Red-billed Leiothrix	*Leiothrix lutea**	X	X	X	PH	C		R
Cutia	*Cutia nipalensis*	X	X	X	HI	C		R

(*continued*)

Appendix. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Black-headed Shrike-Babbler	*Pteruthius rufiventer*	X	X		H	C	Y	R
White-browed Shrike-Babbler	*Pteruthius flaviscapis yunnanensis*		X	X	PHI	C		R
White-browed Shrike-Babbler	*Pteruthius flaviscapis validrostris*	X			PHI	C		R
Black-eared Shrike-Babbler	*Pteruthius melanotis**	X	X	X	H	C		R
White-hooded Babbler	*Gampsorhynchus rufulus*			X	I	E		R
Rusty-fronted Barwing	*Actinodura egertoni*	X	X	X	H	E	Y	R
Streak-throated Barwing	*Actinodura waldeni**	X	X	X	H	C	Y	R
Blue-winged Minla	*Minla cyanouroptera**	X	X	X	PHI	C		R
Chestnut-tailed Minla	*Minla strigula**	X	X	X	H	C		R
Red-tailed Minla	*Minla ignotincta**	X	X	X	PHI	C		R
Golden-breasted Fulvetta	*Alcippe chrysotis**	X	X		HP	C		R
Yellow-throated Fulvetta	*Alcippe cinerea**	X			H	E	Y	R
Rufous-winged Fulvetta	*Alcippe castaneceps castaneceps**	X			HI	C		R
Rufous-winged Fulvetta	*Alcippe castaneceps exul**		X	X	HI	C		R
White-browed Fulvetta	*Alcippe vinipectus**	X	X	X	H	C		R
Chinese Fulvetta	*Alcippe striaticollis*	X			P	E		R
Spectacled Fulvetta	*Alcippe ruficapilla*		X	X	P	E		R
Streak-throated Fulvetta	*Alcippe cinereiceps**		X		P	E		R
Rusty-capped Fulvetta	*Alcippe dubia**		X	X	P	C		R
Brown-cheeked Fulvetta	*Alcippe poioicephala*			X	I	E		R
Gray-cheeked Fulvetta	*Alcippe morrisonia**		X	X	P	E		R
Rufous-backed Sibia	*Heterophasia annectans*			X	I	E		R
Gray Sibia	*Heterophasia gracilis*			X	I	E	Y	R
Black-headed Sibia	*Heterophasia melanoleuca**		X	X	PI	C		R
Beautiful Sibia	*Heterophasia pulchella**	X	X	X	H	C	Y	R
Long-tailed Sibia	*Heterophasia picaoides**			X	H	E	Y	R

(*continued*)

APPENDIX. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Striated Yuhina	*Yuhina castaneceps**				PI	C		R
White-naped Yuhina	*Yuhina bakeri*	X			HI	E	Y	R
Whiskered Yuhina	*Yuhina flavicollis**	X	X	X	HI	C		R
Stripe-throated Yuhina	*Yuhina gularis**	X	X	X	H	C		R
White-collared Yuhina	*Yuhina diademata**		X	X	P	E		R
Rufous-vented Yuhina	*Yuhina occipitalis**	X	X	X	H	C		R
Black-chinned Yuhina	*Yuhina nigrimenta*				PH	C		R
White-bellied Yuhina	*Erpornis zantholeuca*	X	X	X	I	E		R
Brown Parrotbill	*Paradoxornis unicolor**		X	X	H	E	Y	R
Spot-breasted Parrotbill	*Paradoxornis guttaticollis*	X	X	X	PI	C		R
Brown-winged Parrotbill	*Paradoxornis brunneus*	X	X	X	H	C	Y	R
Fulvous-fronted Parrotbill	*Paradoxornis fulvifrons**			X	PH	E	Y	R
Black-throated Parrotbill	*Paradoxornis nipalensis**	X	X	X	PHI	C		R
Lesser Rufous-headed Parrotbill	*Paradoxornis atrosuperciliaris*			X	I	E	Y	R
Greater Rufous-hooded Parrotbill	*Paradoxornis ruficeps*	X			HI	E	Y	R
Gray-headed Parrotbill	*Paradoxornis gularis**		X	X	PHI	C		R
Fire-tailed Myzornis	*Myzornis pyrrhoura**	X	X		H	E	Y	R
Chestnut-flanked White-Eye	*Zosterops erythropleurus**		X	X	P	N		M
Japanese White-Eye	*Zosterops japonicus**				P	E		S
Oriental White-Eye	*Zosterops palpebrosus**		X	X	PI	C		R
Asian Fairy Bluebird	*Irena puella*			X	I	E		M?
Goldcrest	*Regulus regulus*	X			P	E		R
Winter Wren	*Troglodytes troglodytes*	X			P	E		R
Chestnut-vented Nuthatch	*Sitta nagaensis**		X	X	H	C	Y	R
White-tailed Nuthatch	*Sitta himalayensis**		X	X	H	E	Y	R
Yunnan Nuthatch	*Sitta yunnanensis*		X		H	C	Y	R

(*continued*)

Appendix. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Hodgson's Treecreeper	*Certhia hodgsoni*[a]		X		P	C	Y	R
Bar-tailed Treecreeper	*Certhia himalayana*		X		PH	E	Y	R
Rusty-flanked Treecreeper	*Certhia nipalensis**	X			H	E	Y	R
Brown-throated Treecreeper	*Certhia discolor**		X	X	I	E		R
Great Myna	*Acridotheres grandis*		X	X	I	E		R
Crested Myna	*Acridotheres cristatellus*		X	X	P	E		R
Collared Myna	*Acridotheres albocinctus*			X	I	C	Y	R
Common Myna	*Acridotheres tristis*			X	I	E		R
Black-collared Starling	*Sturnus nigricollis*		X	X	I	E		R
Chestnut-tailed Starling	*Sturnus malabaricus*		X	X	I	E		R
Blue Whistling Thrush	*Myophonus caeruleus eugenei?*	X	X	X	I	E		R
Plain-backed Thrush	*Zoothera mollissima**		X	X	H	C	Y	W
Scaly Thrush	*Zoothera dauma*	X	X	X	PHI	C		W
Black-breasted Thrush	*Turdus dissimilis**		X	X	PI	C	Y	R
Chestnut Thrush	*Turdus rubrocanus**		X	X	PHI	C		R
Pale Thrush	*Turdus pallidus*		X	X	P	E		M
Naumann's Thrush	*Turdus naumanni*		X	X	P	E		W
Purple Cochoa	*Cochoa purpurea*			X	PI	C		R
Gould's Shortwing	*Brachypteryx hyperythra*	X			P	C	Y	R
White-browed Shortwing	*Brachypteryx montana*	X	X	X	PHI	C		R
Siberian Rubythroat	*Luscinia calliope**		X	X	P	E		W
Indian Blue Robin	*Luscinia brunnea*		X	X	H	E		S
White-browed Bush Robin	*Luscinia indica**				HI	C		R
Rufous-bellied Bush Robin	*Luscinia hyperythra**	X	X		H	E	Y	S
Red-flanked Bush Robin	*Luscinia cyanura**	X	X	X	PH	C		M
Golden Bush Robin	*Luscinia chrysaea**		X		H	E		S
Oriental Magpie-Robin	*Copsychus saularis**		X	X	PI	C		R
Black Redstart	*Phoenicurus ochruros*		X	X	P	E		R
Hodgson's Redstart	*Phoenicurus hodgsoni*		X	X	p	E		W
White-throated Redstart	*Phoenicurus schisticeps*		X	X	PH	E		R

(*continued*)

APPENDIX. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Daurian Redstart	*Phoenicurus auroreus**	X	X	X	P	E		W
Blue-fronted Redstart	*Phoenicurus frontalis**		X	X	PH	C		R
Plumbeous Water Redstart	*Rhyacornis fuliginosa**	X	X	X	PH	C		R
White-capped Water Redstart	*Chaimarrornis leucocephalus**	X	X	X	PH	C		R
White-tailed Blue Robin	*Myiomela leucura**		X	X	PHI	C		R
Little Forktail	*Enicurus scouleri**	X	X	X	PH	E		R
Black-footed Forktail	*Enicurus immaculatus*				HI	E		V
Slaty-backed Forktail	*Enicurus schistaceus**	X	X	X	PHI	C		R
White-crowned Forktail	*Enicurus leschenaulti**			X	PHI	C		R
Spotted Forktail	*Enicurus maculatus**	X	X	X	PH	C		R
Common Stonechat	*Saxicola torquatus*	X	X	X	P	E		R
Pied Bushchat	*Saxicola caprata*		X	X	I	E		R
Gray Bushchat	*Saxicola ferreus**	X	X	X	PHI	C		R
Blue Rock Thrush	*Monticola solitarius*	X	X	X	PH	C		R
Chestnut-bellied Rock Thrush	*Monticola rufiventris**		X	X	PHI	C		R
Dark-sided Flycatcher	*Muscicapa sibirica*		X	X	PH	C		S
Ferruginous Flycatcher	*Muscicapa ferruginea*		X	X	PH	C		S
Slaty-backed Flycatcher	*Ficedula hodgsonii**		X	X	PH	C		S
Rufous-gorgetted Flycatcher	*Ficedula strophiata**	X	X	X	PH	C		S
Red-breasted Flycatcher	*Ficedula parva**	X		X	P	E		M
Snowy-browed Flycatcher	*Ficedula hyperythra**		X	X	PHI	C		S
Little Pied Flycatcher	*Ficedula westermanni**		X	X	HI	E		S
Ultramarine Flycatcher	*Ficedula superciliaris*			X	H	E	Y	S
Sapphire Flycatcher	*Ficedula sapphira*			X	H	C	Y	S
Asian Verditer Flycatcher	*Eumyias thalassinus**	X	X	X	PHI	C		S
Pale Blue Flycatcher	*Cyornis unicolor*				HI	E		S
Hill Blue Flycatcher	*Cyornis banyumas*		X	X	I	E		S
Rufous-bellied Niltava	*Niltava sundara**	X	X	X	H	C		S

(*continued*)

Appendix. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Large Niltava	*Niltava grandis**		X	X	HI	E		S
Small Niltava	*Niltava macgregoriae**	X			HI	E		R
Gray-headed Canary-Flycatcher	*Culicicapa ceylonensis**	X	X	X	PHI	C		S
Brown Dipper	*Cinclus pallasii**	X	X	X	PHI	E		R
Golden-fronted Leafbird	*Chloropsis aurifrons*			X	HI	E		M?
Orange-bellied Leafbird	*Chloropsis hardwickei*		X	X	HI	E		R
Yellow-vented Flowerpecker	*Dicaeum chrysorrheum*			X	I	E		R
Yellow-bellied Flowerpecker	*Dicaeum melanoxanthum**	X	X	X	HI	E		R
Plain Flowerpecker	*Dicaeum concolor*		X	X	PI	C		R
Fire-breasted Flowerpecker	*Dicaeum ignipectum**	X	X	X	PHI	C		R
Mrs. Gould's Sunbird	*Aethopyga gouldiae**	X	X	X	PHI	C		R
Green-tailed Sunbird	*Aethopyga nipalensis**	X	X	X	HI	C		R
Black-throated Sunbird	*Aethopyga saturata**	X	X	X	HI	E		R
Crimson Sunbird	*Aethopyga siparaja*		X	X	HI	E		R
Little Spiderhunter	*Arachnothera longirostra*	X			I	E		R
Streaked Spiderhunter	*Arachnothera magna*			X	HI	E		R
Russet Sparrow	*Passer rutilans*	X	X	X	PHI	C		R
Eurasian Tree Sparrow	*Passer montanus*		X	X	PHI	C		R
Boya Weaver	*Ploceus philippinus*			X	I	E		R
Red Munia	*Amandava amandava*		X	X	I	E		R
Scaly-breasted Munia	*Lonchura punctulata**	X	X	X	PHI	C		R
Black-headed Munia	*Lonchura malacca*		X	X	I	E		R
Alpine Accentor	*Prunella collaris*	X			PH	E		R
Rufous-breasted Accentor	*Prunella strophiata**	X			H	E	Y	R
Maroon-backed Accentor	*Prunella immaculata**		X	X	H	C	Y	W
Yellow Wagtail	*Motacilla flava*	X			P	E		M
Citrine Wagtail	*Motacilla citreola*	X	X	X	P	E		M
Gray Wagtail	*Motacilla cinerea*	X	X	X	P	E		M
White Wagtail	*Motacilla alba**	X	X	X	P	E		W
Richard's Pipit	*Anthus richardi*	X	X	X	P	E		W
Olive-backed Pipit	*Anthus hodgsoni yunnanensis*	X	X	X	PH	E		W
Olive-backed Pipit	*Anthus hodgsoni hodgsoni*	X		X	PH	E		S

(*continued*)

APPENDIX. Continued.

English name	Scientific name	North GLGS	Middle GLGS	South GLGS	Biogeographic provinces	Edge	Limited range	Resident status
Rosy Pipit	*Anthus roseatus**		X	X	PH	E		S
Water Pipit	*Anthus spinoletta*	X			P	E		W
Brambling	*Fringilla montifringilla**	X	X		P	E		M
Tibetan Siskin	*Carduelis thibetana*		X		H	C	Y	R
Black-headed Greenfinch	*Carduelis ambigua*		X	X	PH	C	Y	R
Plain Mountain Finch	*Leucosticte nemoricola*	X			PH	E		R
Dark-breasted Rosefinch	*Carpodacus nipalensis**		X		H	E	Y	R
Common Rosefinch	*Carpodacus erythrinus*	X			PH	E		R
Vinaceous Rosefinch	*Carpodacus vinaceus**		X		H	C	Y	R
Dark-rumped Rosefinch	*Carpodacus edwardsii**		X		H	C	Y	R
Crimson-browed Finch	*Pinicola subhimachala**		X	X	H	E	Y	W
Scarlet Finch	*Haematospiza sipahi*	X		X	H	C	Y	S
Gray-headed Bullfinch	*Pyrrhula erythaca*		X	X	PH	E		R
Collared Grosbeak	*Mycerobas affinis*			X	H	C	Y	R
Spot-winged Grosbeak	*Mycerobas melanozanthos*	X		X	H	C	Y	S
Gold-naped Finch	*Pyrrhoplectes epauletta**	X	X	X	H	C	Y	S
Crested Bunting	*Melophus lathami*		X	X	HI	C		R
Chestnut-eared Bunting	*Emberiza fucata*	X			PH	E		S
Little Bunting	*Emberiza pusilla**	X	X	X	P	E		M
Yellow-throated Bunting	*Emberiza elegans**		X	X	P	E		S
Yellow-breasted Bunting	*Emberiza aureola*		X	X	P	E		W
Black-faced Bunting	*Emberiza spodocephala*	X		X	P	E		W

[a]Deviations from Dickinson (2003) include *Certhia hodgsoni* (Tietze et al. 2006), *Phylloscopus occisinensis* (Martens et al. 2008), and *P. forresti* (Martens et al. 2004). See the following notes for recent taxonomic updates and our decisions for this paper.

Notes: *Phylloscopus occisinensis* is a tentative estimate, as the range for this species is not well known. Our collecting localities in the GLGS are located geographically between the localities for known *P. occisinensis* and *P. affinis*, but somewhat closer to that of *P. occisinensis*.

Our specimens of *P. inornatus* were identified by Yang Lan and Yang Xiaojun to subspecies as *P. i. inornatus* and were mostly collected at the end of October and the beginning of April, and thus were likely winter residents. The species was also reported by Xue et al. (1995) as a summer resident. If they accurately reported a breeding individual, it is more likely *P. humei* (Irwin et al. 2008).

Specimens identified morphologically as *P. proregulus* are likely *P. forresti*. Again, the GLGS lies between sampling regions of *P. chloronotus* in the central Himalayan ranges, and the type locality of *P. forresti* in the Lichiang Range, so it will be important to confirm this identification with genetic techniques (Martens et al. 2004). Our specimens were collected in late October and early November (15 specimens) and in late April (3 specimens). Given that multiple other cryptic species of the *P. proregulus* superspecies may share sympatric winter ranges, these identifications are only tentative.

Recent revisions have been suggested for *P. reguloides* (Olsson et al. 2005). According to their collecting localities, our specimens would most likely belong with *P. ticehurti*. This taxon was not strongly supported and is not widely recognized. If synonymized, it would become a subspecies or population of *P. reguloides*. It is possible that the GLGS birds belong to the taxon *P. claudiae*, but the known specimens of *P. claudiae* appear to have been collected in Sichuan province more distant from the GLGS. We prefer to recognize the GLGS specimens as *P. reguloides* until additional data are available.