

Bird Diversity, Biogeographic Patterns, and Endemism of the Eastern Himalayas and Southeastern Sub-Himalayan Mountains

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Source: Ornithological Monographs No. 70

Published By: American Ornithological Society

URL: <https://doi.org/10.1525/om.2011.70.1.153>

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CHAPTER 8

BIRD DIVERSITY, BIOGEOGRAPHIC PATTERNS, AND ENDEMISM OF THE EASTERN HIMALAYAS AND SOUTHEASTERN SUB-HIMALAYAN MOUNTAINS

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ABSTRACT.—Species distribution and species diversity pattern have vexed ornithologists in Southeast Asia and the Himalayas. The species diversity debate continues, because the baseline data for such analysis are still very incomplete, especially in some parts of Asia. We conclude, from currently available data sets such as museum specimens, that the ornithological affinities of northern Kachin State are rather with the eastern sub-Himalayas and western Yunnan, and we cannot (yet) confirm a spatially narrow turnover zone between South and Southeast Asia. Nevertheless, the local endemism of bird species (i.e., sub-Himalayan slopes of northern Kachin State) is high and there is a strongly marked elevational turnover from south to north. Recent surveys in Assam, Arunachal Pradesh (northeast India), Yunnan (southwest China), and Kachin State (northern Myanmar) have revealed taxa not previously known, including three from Arunachal Pradesh and Kachin State since 1997. The descriptions are based on museum work in combination with genetic analysis and extensive field studies (e.g., *Jabouilleia naungmungensis* and *Tesia olivea chiangmaiensis*). Additionally, several taxa have been revised on the basis of new insights from surveys of the region (e.g., *Cyornis banyumas*–*C. magnirostris*) or phylogenetic analysis (e.g., *Phylloscopus*). We present data on these new species and discuss distributional areas in the context of species richness gradients.

Key words: collection gaps, distribution gaps, new descriptions, species distribution, species richness, taxon rank change.

Diversidad de Aves, Patrones Biogeográficos y Endemismo de los Himalayas del Este y de las Montañas Sub-Himalayas del Sudeste

RESUMEN.—En el sudeste de Asia y en los Himalayas los patrones de distribución y diversidad de especies han sido un problema para los ornitólogos. El debate sobre la diversidad de especies continúa porque los datos de base para realizar ese tipo de análisis todavía son muy incompletos, especialmente en algunas parte de Asia. A partir de base de datos disponibles actualmente, tales como conjuntos de especímenes de museo, concluimos que las afinidades ornitológicas del norte del estado de Kachin son más bien con el este de los sub-Himalayas y el oeste de Yunnan, y no podemos confirmar (todavía) una zona estrecha de intercambio entre el sur y sudeste de Asia. Sin embargo, el endemismo local de especies de aves (i.e., en las laderas subhimalayas en norte del estado de Kachin) es alto y existe un fuerte recambio de especies con la elevación desde el sur al norte. Muestreos recientes en Assam, Arunachal Pradesh (noreste de India), Yunnan (sudoeste de China) y en el estado de Kachin (norte de Birmania [Myanmar]) han revelado la existencia de taxones desconocidos hasta el momento, incluyendo tres de Arunachal

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Pradesh y del estado de Kachin desde 1997. Las descripciones se basaron en trabajos de museo en combinación con análisis genéticos y estudios de campo intensos (e.g., *Jabouilleia naungmungensis* y *Tesia olivea chiangmaiensis*). Adicionalmente, varios taxones han sido revisados con base en nuevas apreciaciones provenientes de muestreos hechos en la región (e.g., *Cyornis banyunus*–*C. magnirostris*) o de análisis filogenéticos (e.g., *Phylloscopus*). Presentamos datos sobre estas nuevas especies y discutimos las áreas de distribución en el contexto de gradientes de riqueza de especies.

AVIAN SPECIES RICHNESS is very high in northern Kachin State (Myanmar, the former Burma) and adjacent Assam–Arunachal Pradesh (India) as well as Tibet and Yunnan (China) (e.g., Martens and Eck 1995; Renner et al. 2007; Chapters 2 and 3, present volume). New descriptions of taxa from the greater Himalayan Mountains (area definitions are explained in detail in Chapter 1, present volume) are steadily increasing the known species number. Earlier analyses established patterns of bird species richness among the Palearctic, south and continental Southeast Asia (Stanford and Ticehurst 1935a, b, 1938a, b, c, d, 1939a, b; Stanford and Mayr 1940, 1941a, b, c, d). Later, researchers aimed to conceptually explain patterns of species richness (e.g., Martens and Eck 1995, Cox 2001, Cox and Moore 2005; cf. summary in Chapter 1, present volume). New baseline data, as presented throughout this volume of *Ornithological Monographs*, add new insights to such discussions from the area of interest (i.e., the eastern Himalayas and the adjacent southeastern sub-Himalayan Mountains of northern Kachin State and western Yunnan; cf. Chapter 1, present volume: Fig. 2). Here, we aim to discuss these new data regarding bird species richness and endemism to establish whether or not the southeastern sub-Himalayan avifauna is a hotspot of endemism (and hence distinctive from all adjacent areas) or can be assigned to one of the adjacent areas (hence the avifauna is similar to the Palearctic, South Asia, the central and eastern Himalayas, or continental Southeast Asia).

Taxonomy is an essential prerequisite to establishing species distribution patterns. For Southeast Asia, data for taxonomic assessment for many bird taxa are incomplete or lacking (compare, for instance, discussion between Collar [2008] and Peterson and Moyle [2008]), and many groups need considerable revision (Stattersfield et al. 1998; Rappole et al. 2005, 2008; Renner et al. 2007, 2008, 2009). To worsen this problem, several new species have been discovered recently in the greater Himalayan region, and these new taxa with unresolved

phylogenetic relationships contribute considerably to this confusion (for example, the warblers are still subject to heated debate; see below). To demonstrate that taxonomy is an important factor in species distribution analysis for Southeast Asia, we analyze the global increase in new bird taxa and discuss the relevance for our analysis of species distribution patterns in our area of interest.

We outline the current knowledge on distribution of all avian taxa in the greater Himalayan Mountains and establish whether the area is unique (i.e., a regional hotspot) or, rather, belongs to one of the larger zoogeographic regions (cf. discussion in Chapter 1, present volume). We contrast the current knowledge on distribution with similar analysis from the mid-20th century and discuss the influence of taxonomic discussion, recent discoveries of new avian taxa on such analysis, and the database for the analysis. To place our findings on taxonomic changes in a global context, we also test whether the sub-Himalayan Mountains of northern Myanmar are a “hotspot” of new discoveries. We test whether the Hkakabo Razi region has a different species assemblage than the four neighboring regions ($H_0: \mu_{HK} - \mu_y = 0$, where μ_{HK} is the presence of species in the Hkakabo Razi–Putao area and μ_y is the presence of species elsewhere, with $y =$ Tenasserim, Eastern Himalayan Mountains, northwest Thailand, or western Yunnan).

METHODS

New taxa from South and Southeast Asia.—We performed a literature search for new (1997–2008) descriptions of avian taxa from South and Southeast Asia, and we discuss some of these that are relevant for the area of interest. The area of interest was at least partly inaccessible because of war and political unrest from the late 1930s until 1997 (see Chapter 2, present volume). We discuss new findings where appropriate. The discussion on the taxonomy is relevant for the regional analysis of species distributions.

Regional analysis of species distributions.— Commonly used approaches for species distribution analysis, such as those used for Africa and the Neotropics (Fjelds  et al. 1999, Rahbeck 2005, Fjelds  2007, Global Biodiversity Information Facility [GBIF] 2009), are not suitable for most of Asia, because data are lacking for some parts of Asia (e.g., Rasmussen and Anderton 2005, Robson 2008, J. Fjelds  pers. comm.). Therefore, we performed an analysis using an entirely different approach in order to have a first approximation on whether the taxa “belong” (as a proxy for “originate from”) more to South Asia as opposed to Southeast Asia. Our approach was to analyze the distributional range for all taxa that occur in Putao (recorded by us and confirmed by collaborators). We include all species for which we have found at least one taxon (subspecies) occurring in the larger area of either Kachin State, Yunnan, or Arunachal Pradesh/Assam, or both. To increase our data reliability, we focused on the subset of taxa with three specific criteria. (1) We only analyzed taxa for which we could export specimens from northern Myanmar; this was important so that we could directly compare plumage characteristics in collections and correct subspecies assignment without relying on field-guide descriptions or photographs. (2) Subsequently, we compared all our exported specimens with those from our reference collection (U.S. National Museum of Natural History, Smithsonian Institution) and assigned the taxon to the most likely subspecies (if available and relevant) present there. We added data from other collections (acronyms as in Acknowledgments: AMNH, ANSP, BMNH, CAS) for the general distribution of subspecies for the relevant taxa, amended by references on subspecies distribution where possible (Kazmierczak and van Perlo 2000, Robson 2000, Rasmussen and Anderton 2005). (3) We used only species for which we were certain that subspecies differences were known (whether described or based on our own unpublished data).

We then compared the entire subspecies distribution by determining each subspecies’ distributional range. We specifically looked for subspecies that were (1) restricted to Arunachal Pradesh and/or westward (Himalayan Mountains); (2) restricted to central Yunnan and/or eastward; (3) restricted to northern and/or northwestern Thailand and/or southward; (4) restricted to the Hkakabo Razi National Park and

immediate environs, specifically extreme western Yunnan (Gaoligong Shan, Nu Shan); or (5) distributed in any combination of the above. Using these criteria, we were able to analyze the distributional ranges of 67 taxa. The taxa included here are limited only by current knowledge on distribution and subspecies (and hence are not biased by collection or export activity). The taxa used for the analysis are a good subsample of the 413 taxa known from northern Myanmar (see Chapter 2, present volume). This iterative exclusion procedure guarantees small errors of taxonomy and reduced errors in distributional ranges. Unfortunately, this exclusion is a tradeoff between large *N* for analysis and precision; we decided to increase precision.

Global analysis of new taxa.—We surveyed all literature available for new taxa recently described on a global scale. At a first approximation we did not check whether or not these species were described correctly or should be considered to represent a different taxon level. We also did not check whether the authors followed ICZN guidelines (International Commission on Zoological Nomenclature 2009). However, similar reviews for the region have been performed by several authors (e.g., Collar 2006, 2008; Collar and Pilgrim 2007; Collar and Robson 2007; Martens and Bahr 2007). The review of all species, subspecies, and genera is mainly for species of the region in the border area between Palearctic, South, and Southeast Asia. For practical reasons we focus here on new descriptions published from 2002, as opposed to the accessibility of the area of interest starting in 1997 (compare above). We focus mainly on genuinely new taxa and do not include actual or pending name changes for taxon rank-level changes. After Mayr and Stanford (Stanford and Ticehurst 1935a, b, 1938a, b, c, d, 1939a, b; Stanford and Mayr 1940, 1941a, b, c, d) up to 2002, no species have been described from northern Myanmar or the eastern sub-Himalayan Mountains of Myanmar. Hence, no species were described from there between 1991 and 2002, to our knowledge.

RESULTS

New taxa from South and Southeast Asia.— Between 1991 and 2008, several genuinely new taxa have been described from the greater Himalayan Mountains (Rappole et al. 2005, Athreya

2006, Fang and Aiwu 2008, Renner et al. 2008), and taxonomy and species distribution ranges have been corrected (e.g., *Cyornis magnirostris*; Renner et al. 2009), subspecies have been elevated to species rank, and species have been split (Rasmussen and Anderton 2005, Collar and Pilgrim 2007). The only regions remotely approaching our area in terms of number of genuinely new species are the Philippines and Indonesia, where four and seven new species have been described since 1997 (note different period; cf. summary by Li 2008), or the northern Andes in Colombia.

In the following numbered sections, we discuss those cases of new species descriptions where we disagree with the conclusions on taxon level arrived at by other researchers, or where we can add new insights based on our work in the greater Himalayan region.

(1) *Jabouilleia naungmungensis* Rappole, Renner, Nay Myo Shwe, and Sweet, 2005.—*Jabouilleia naungmungensis* is a newly described taxon from the area of interest, recognized as a species in its original description but downgraded to a subspecies of *J. danjoui* (Vietnam, Laos) in some subsequent publications (cf. Collar 2006, 2008; Collar and Pilgrim 2007; Collar and Robson 2007; and discussion in Peterson and Moyle 2008). Given the apparently allopatric distribution of *J. naungmungensis* (known only from the Naung Mung area of northern Myanmar) and its closest known relative, *J. danjoui* (Vietnam, 850 km to the east), it is certainly possible that the two taxa are conspecific. However, the decision to recognize *J. naungmungensis* as a species-level taxon was based on major differences in three classes of data: measurements, plumage, and molecular genetics. Therefore, allopatric distribution is a fourth hint that the taxon should be regarded as a species rather than a subspecies. Measurements: Bill length, innermost rectrix, tarsus, and halux nail are significantly different between *J. naungmungensis* and the Vietnam taxa (Table 1). Plumage: *J. danjoui* and its relatives from Vietnam have a distinct, brownish breast band across a white breast; *J. naungmungensis* lacks a breast band. Genetics: Cytochrome *b* for *J. naungmungensis* differs from that of the Vietnamese taxa by >3% (S. Reddy unpubl. data). These differences still justify the species level, even if considering the placement in the very diverse Timaliidae.

Recently, *J. naungmungensis* was visually observed in extreme western Yunnan, China (24°46'N, 97°34' E; J. Hornskov pers. comm. [2009]). This

observation represents a range extension of 305 km to the south-southeast, increasing the possibility that the species might be found eastward in valleys of the Gaoligong Shan.

(2) *Parus ater eckodedicatus* Martens, Tietze, and Yue-Hua Sun, 2006.—The split from *Parus ater aemodius* was needed to reflect size, coloration, and marked differences in cytochrome *b* (Martens et al. 2006). *Parus a. eckodedicatus* occurs in Yunnan, Sichuan, and Gansu (China). *Parus a. eckodedicatus* is smaller than *P. a. aemodius*, but otherwise is similar. Genetic differences are marked. Cytochrome-*b* sequences of *eckodedicatus* differ by 2.3% from populations in the Himalayas or Eurasia.

(3) *Liocichlia bugunorum* Athreya, 2006.—Publication of the description for this new species is a special case, in that no voucher specimen was collected to document the discovery. Justification for this aberrant course of action was based on the assumption that very few individuals of the species remain. Without a voucher, significant taxonomic issues cannot be resolved, so the validity of this species description remains uncertain until a specimen is stored in a museum with access for all taxonomists (International Commission on Zoological Nomenclature 2009). (Note: at the time of the reviewing process, a discussion emerged in several forums on the topic of vouchers, for instance in AVECOL-L.)

(4) *Tesia olivacea chiangmaiensis* Renner, Rappole, Rasmussen, Thein Aung, Myint Aung, Nay Myo Shwe, Dumbacher, and Fleischer, 2008.—The description of the new taxon emphasizes that the area of interest might be split into two zoogeographic regions, with the narrow turnover zone in northern Kachin State. Several subspecies (cf. Table 2) have similar distribution. In addition, the finding of this taxon suggests careful revision of museum specimens, because the taxon was discovered by luck in a collection.

(5) *Stachyris nonggangensis* Zhou Fang and Ji-ang Aiwu, 2008.—Just recently described, this new species is found in a small forest patch in southern Guanxi Province, southwest China. The habitat is well-developed seasonal karst rainforest that extends along the Sino-Vietnamese border.

(6) *Phylloscopus occisinesis* Martens, Yue-Hua Sun, and Päckert, 2008.—The description of this new species is supported by phylogenetic and vocalization data. Its distribution extends from Yunnan northward through Sichuan to Qinghai.

TABLE 1. (A) Morphometrics of all available *Jabouilleia* specimens (all measurements by S.C.R.). Results from analysis of variance (ANOVA) are summarized on the next page. Probably all available *Jabouilleia* specimens globally are included here (d = defective, missing, or molting feature and consequently not measured). Abbreviations: USNM = U.S. National Museum of Natural History, Smithsonian Institution; AMNH = American Museum of Natural History, New York; BNHM = The Natural History Museum, Tring, United Kingdom; ANSP = Academy of Natural Sciences, Philadelphia; and MHNP = Museum Histoire Naturel de Paris.

Collection number	Sex	Location	Date collected	Bill length ^a	Bill width ^b	Bill height ^b	Wing	Innermost rectrix	Outermost rectrix	Tarsus	Halux nail
<i>J. naungmungensis</i>											
USNM 633.212	F	Naung Mung	6 February 2004	33.3	4.2	5.3	76.9	50.5	44.0	d	d
USNM 633.213	F	Naung Mung	6 February 2004	33.5	4.6	5.1	77.7	52.4	40.2	33.3	10.1
USNM 633.214	F	Naung Mung	8 February 2004	33.7	4.9	5.1	70.5	54.9	47.6	35.0	9.8
USNM	M	Naung Mung	13 March 2006	31.8	d	d	74.4	54.9	d	32.3	10.6
USNM	—	Naung Mung	20 March 2006	—	—	—	—	—	—	—	9.5
<i>J. parvirostris</i>											
BMNH 1998.71.14	M?	Cong Trou, Kon Tum	26 April 1998	23.3	4.5	4.8	72.0	54.7	43.4	26.1	7.9
AMNH 833.674	F	Ha Giang Prov., Mount Tay Con Linh	11 May 2000	—	—	—	—	—	—	—	—
MHNP	M	Bauo Bamo?	14 August 1929	23.3	5.2	d	72.9	d	d	27.0	8.6
<i>J. danjoui</i>											
MHNP	M	South Annam, Ojiring	15 April 1909	21.2	4.3	4.9	71.1	54.1	50.0	29.3	9.0
BMNH 1919.12.20.533	M	Langbian Peaks	20 April 1918	31.4	4.3	5.0	64.1	d	d	26.0	7.6
BMNH 1927.6.5.891	F	Djiring	11 March 1927	27.0	d	d	74.3	58.2	49.2	26.8	8.8
BMNH 1919.12.20.280	F	Dalat	8 April 1918	28.4	4.6	5.3	75.9	61.2	45.5	29.5	8.2
BMNH 1927.6.5.890	M	Djiring	11 March 1927	29.5	4.5	5.3	80.2	68.1	54.1	29.9	9.2
USNM 278.487	M	Langbian	24 May 1961	28.6	4.9	4.6	64.6	60.6	50.5	29.1	8.1
USNM 475.738	F	Langbian	1 December 1939	27.1	4.3	4.8	71.9	61.1	44.7	32.3	8.8
USNM 360.907	M	Langbian	24 August 1918	30.3	5.0	4.7	73.8	62.0	51.0	31.6	8.5

^aTip to proximal end of operculum–nares.

^bMeasured at distal end of operculum–nares.

^cOne-way ANOVA (* $P < 0.05$). n.s. = not significant; if $P < 0.05$, all pairwise multiple-comparison-procedure results are shown ($P = 0.05$). [†]Normality test failed ($P < 0.05$), ANOVA on ranks with Kruskal-Wallis performed and one-way analysis results are shown.

TABLE 1. (B) Summary statistics of measurements.

	Bill length ^a	Bill width ^b	Bill height ^b	Wing	Innermost rectrix	Outermost rectrix	Tarsus	Halux nail
ANOVA ^c	[†] 0.001	n.s.	n.s.	n.s.	0.009	n.s.	0.006	0.001
<i>J. naungmungensis</i> vs. <i>J. parvirostris</i>	*	n.s.	n.s.	n.s.	n.s.	n.s.	*	*
<i>J. naungmungensis</i> vs. <i>J. danjoui</i>	*	n.s.	n.s.	n.s.	*	n.s.	*	*
<i>J. parvirostris</i> vs. <i>J. danjoui</i>	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
N	14.0	12.0	11.0	14.0	12.0	11.0	13.0	14.0
Max <i>J. naungmungensis</i>	33.7	4.9	5.3	77.7	54.9	47.6	35.0	10.6
Min <i>J. naungmungensis</i>	31.8	4.2	5.1	70.5	50.5	40.2	32.3	9.5
Average <i>J. naungmungensis</i>	33.1	4.6	5.2	74.9	53.2	43.9	33.5	10.0
Max <i>J. danjoui</i>	31.4	5.2	5.3	80.2	68.1	54.1	32.3	9.2
Min <i>J. danjoui</i>	21.2	4.3	4.6	64.1	54.1	43.4	26.0	7.6
Average <i>J. danjoui</i>	27.0	4.6	4.9	72.1	60.0	48.5	28.8	8.5

^aTip to proximal end of operculum-nares.

^bMeasured at distal end of operculum-nares.

^cOne-way ANOVA (* $P < 0.05$). n.s. = not significant; if $P < 0.05$, all pairwise multiple-comparison-procedure results are shown ($P = 0.05$). [†]Normality test failed ($P < 0.05$), ANOVA on ranks with Kruskal-Wallis performed and one-way analysis results are shown.

In addition to these newly-described taxa, there have been several “new” species for the area of interest based on suggested promotion of subspecies to species-level recognition.

(7) Collar (2006) suggested 46 changes in species-level taxonomy of Asian Timaliidae, of which at least five are relevant for the area of interest. He split, for example, *Garrulax erythrocephalus* (*Trochalopteron erythrocephalum*) into four species, *Pomatorhinus erythrocnemis* into three, and follows Rasmussen and Anderton (2005) in taxonomy for the split of *roberti* from *Sphenocichlia humei*. These suggested changes were based primarily on plumage differences. The suggested changes have not been peer reviewed and still need to be considered by the relevant taxonomic committee before they can be accepted.

(8) *Cuculus saturatus-complex*.—*Cuculus saturatus* (sensu lato) has been split into three species, at least two of which are clearly distinctive on the basis of differences in their vocalizations (King 2005, Martens and Bahr 2007, J. C. Eames pers. comm. [2009]): *C. saturatus* (sensu stricto) in Himalayas to South China, *C. optatus* (= *horsfieldi*) in east Europe to Japan, northern north China, and *C. lepidus* in Peninsula Malay and the Sundas. *Cuculus lepidus* is somewhat smaller and distinctively colored, but vocalizations of *C. lepidus* are less distinctive from *C. saturatus* (Payne 1997).

(9) *Caprimulgus indicus*.—Rasmussen and Anderton (2005) split the Indian populations of

C. indicus including ssp. *kelaarti* in Sri Lanka into two species: *C. indicus* and *C. jotaka*. *Caprimulgus jotaka* is limited to the Himalayas of northeast India, and so far no overlap has been observed with *C. indicus* (sensu stricto). The split is supported by differences in vocalizations and egg color.

(10) *Parus xanthogenys*.—Rasmussen and Anderton (2005) elevated both known subspecies to the species level on the basis of color and voice differences. The superspecies occurs in the Himalayas. Eck and Martens (2006) considered the data insufficient.

(11) *Parus major-complex*.—Discussion is ongoing on how to distinguish species and subspecies of this widely distributed taxon, overlapping slightly with the area of interest in north China. Genetic, morphometric, and vocalization characters are not all very clear and are partly contradicting. Several authors suggest—on the basis of genetic analysis and vocalizations—to split *P. minor* and *P. cinereus* from *P. major* (Päckert et al. 2005, Eck and Martens 2006). Obviously, more work is needed to satisfy all working groups and establish a profound taxonomy for this clade (cf. Chapter 4, present volume).

(12) *Phylloscopus reguloides-complex*.—*Phylloscopus reguloides* is quite abundant in the Himalayas, China, and Southeast Asia. Taxonomy and phylogenetics will significantly change analysis of species richness in the area of interest, because—pending on what taxonomy is followed for such

analysis—the taxon number in the area of interest will change somewhat. The taxon has been split into several subspecies, and taxonomists continue to discuss the validity of subspecies and their elevation to full species. While cytochrome-*b* shows clearly distinctive clusters (Olsson et al. 2005), plumage, vocalizations, and distribution have not yet been analyzed in detail (discussed by Clement 2006, Martens and Bahr 2007).

(13) *Phylloscopus davisoni-complex*.—Olsson et al. (2005) recognized two species within this taxon: *P. davisoni*, whose distribution covers parts of Yunnan, north and east Myanmar, northern Thailand, northern Laos, and central Vietnam; and *P. ogilviegranti* with three subspecies from west to southeast China and Indochina. Clement (2006) and Martens and Bahr (2007) were reluctant to adopt the changes without further documentation of supporting material.

(14) *Carpodacus sp.*—Rasmussen (2005) and Rasmussen and Anderton (2005) suggested splitting a further four species from the known species of this group, two of which occur in our area of interest. Rasmussen (2005) and Rasmussen and Anderton (2005) split *C. verreauxi* (Yunnan/Kachin) from *C. rodopeplus* (west and central Himalaya) and *C. thura* (west and central Himalaya) from *C. dubius* (Tibet, Yunnan, Sichuan). Martens and Bahr (2007) discussed these splits and concluded that the splits in some cases might be valid but need more documentation.

(15) *Cyornis magnirostris*.—On the basis of morphometrics and parapatric distribution, the taxon *magnirostris*, which is found in northern Kachin State and northeast India, should be treated as a separate species from *C. banyumas*. Vocalization and DNA analyses are currently underway (Renner et al. 2009).

In general, there is much taxonomic work and revision left to be done in the region. Three additional taxa that were recently named in adjacent areas support our statement that the southeastern sub-Himalayan Mountains are a global hotspot of new bird descriptions. The additional taxa described from Southeast Asia but not yet reported from the area of interest are *Garrulax konkakinhensis* (Eames and Eames 2001), *Motacilla samveasnae* (Duckworth et al. 2001), and *Pycnonotus hualon* (Woxvold et al. 2009).

At least 353 new species have been discovered in the eastern Himalayas between 1998 and 2008. The discoveries include 242 plants, 16 amphibians, 16 reptiles, 14 fishes, 2 birds, 2 mammals,

and at least 61 new invertebrates (Rabinowitz et al. 1999, Saw Lwin 1999, Slowinski and Wüster 2000, Slowinski et al. 2001, Ferraris 2004, Kovarik 2004, World Wide Fund for Nature 2009), lending considerable support to our claim for the region as an area of extraordinarily high endemism.

Regional analysis of species distribution.—Of the 413 species known to occur in the Hkakabo Razi–Putao area (see Chapter 2, present volume), we have been able to establish the distributional ranges for 67. This group includes resident birds only, excluding all species of cosmopolitan distribution (because all of them occur in areas we look at anyway) or that we did not confirm as breeding species (i.e., this group includes also birds we frequently encountered on a daily basis while in the area of interest or in immature or subadult plumages) during the early breeding season. Thus, about 50% of all residents with limited distributional range were used in the analysis.

Of these 67 resident species of known range and confirmation for the Hkakabo Razi–Putao area, 62 (92.5%) are also found in the eastern Himalayan Mountains (Table 2), and 41 (61.2%) are also found in western Yunnan, bordering the Hkakabo Razi–Putao area; only 33 (49.2%) and 39 (58.2%) are found also in northwest Thailand and Tenasserim, respectively (Table 2). However, if performing a test, the Hkakabo Razi–Putao area has a significantly different taxon composition from all four other regions (Hkakabo Razi–Putao area vs. all others; Wilcoxon signed rank test: $P < 0.04$; or paired *t*-test if normally distributed: $P < 0.001$).

On the basis of this preliminary analysis of the regional avifauna, the principal affinity for the avifauna of the Hkakabo Razi region appears to northeast India. Twenty-six of the species we found in the Hkakabo Razi region are not found in Gaoligong Shan (~40 km to the east) but are found in Arunachal Pradesh (>80 km to the west; compare results and discussion of Chapters 1, 2, 3, and 7 in the present volume). Many subspecies, however, are endemic to the region, distinguishing the Hkakabo Razi avifauna also from that of northeast India.

Global analysis of new species descriptions.—We found that from 2002 until the beginning of 2008, a total of 68 new bird species were described worldwide (Peterson 2008; cf. Renner and Rap-pole 2009).

The largest number of genuinely new taxa have been described from the Neotropics (Fig. 1), and none are from North America, Europe, or the

TABLE 2. Affinities of subspecies from the Hkakabo Razi region to India, Thailand, or China (Yunnan). Listed are all species with subspecies distributions that meet the criteria outlined in the text. Distributions significantly rely on taxonomy and might be quite different if other opinions of taxonomy were applied. An asterisk indicates data derived from the collections of the Natural History Museum, Tring, United Kingdom, and the U.S. National Museum of Natural History, Smithsonian Institution; all other data represent a combination of literature and collection work.

Sequence	Species	Affinity of Hkakabo Razi taxon to subspecies of				Hkakabo Razi Region (including Naung Mung and Putao)
		Northwestern Thailand ^a	Himalayan Mountains ^b	Tenasserim ^c	Western Yunnan ^d	
1	<i>Actinodura egertoni</i> *	—	X	—	X	X
2	<i>Actinodura waldeni</i> *	—	X	X	X	X
3	<i>Aethopyga nipalensis</i> *	X	X	X	—	X
4	<i>Aethopyga saturata</i> *	X	X	X	X	X
5	<i>Alcippe cinereiceps</i> *	—	X	—	X	X
6	<i>Alcippe rufogularis</i>	—	X	—	—	X
7	<i>Alcippe vinipectus</i> *	—	X	“Central” Myanmar	X	X
8	<i>Alophoixus flaveolus</i>	—	X	X	—	X
9	<i>Arachnothera magna</i> *	X	X	X	—	X
10	<i>Brachypteryx hyperythra</i> *	—	X	—	—	X
11	<i>Brachypteryx leucophrys</i> *	—	X	Probably?	X	X
12	<i>Chloropsis hardwickii</i> *	—	X	—	X	X
13	<i>Cinclus pallasi</i> *	Probably	X	Probably	X	X
14	<i>Coracina melaschistos avensis</i> *	X	X	X	X	X
	(ssp. covering all the area of Himalayas to Southeast Asia)					
15	<i>Culicicapa ceylonensis</i> *	X	X	X	X	X
16	<i>Cyornis magnirostris</i> *	—	X	Migrant	—	X
17	<i>Delichon dasypus</i> *	—	X	—	X	X
18	<i>Ficedula hyperythra</i> *	—	X	—	—	X (also in Sundas)
19	<i>Garrulax affinis</i> *	—	X	—	X	X
20	<i>Garrulax erythrocephalus</i> *	Western Thai	X	X	—	X
21	<i>Garrulax leucolophus</i>	Southeast Thailand	X	X	X	X
22	<i>Garrulax [chinensis] nuchalis</i> *	—	X	—	—	X
23	<i>Garrulax striatus</i> *	—	X	—	—	X
24	<i>Hemixos flavala</i> *	—	—	—	X	X
25	<i>Hirundo rustica</i> *	X	X	X	X	X
26	<i>Hirundo daurica</i> *	X	X	X	X	X
27	<i>Hypsipetes mclellandi</i> *	X	X	X	X	X
28	<i>Jabouilleia naungmungensis</i> *	—	—	—	(Sight record?)	X
29	<i>Lanius cristatus</i> *	X	X	X	X	X
30	<i>Leiothrix argentauris</i> *	X	X	X	—	X
31	<i>Liocichla phoenicea</i> *	—	X	—	—	X
32	<i>Minla cyanouroptera</i> *	Cambodia	X	X	X	X

TABLE 2. Continued.

Sequence	Species	Affinity of Hkakabo Razi taxon to subspecies of				Hkakabo Razi Region (including Naung Mung and Putao)
		Northwestern Thailand ^a	Himalayan Mountains ^b	Tenasserim ^c	Western Yunnan ^d	
33	<i>Minla ignotincta</i> *	—	X	X	—	X
34	<i>Muscicapa sibirica</i> *	—	—	—	—	Migrant
35	<i>Napothera brevicaudata</i> *	X	X	X	—	X
36	<i>Napothera epilepidota</i> *	X	X	X	—	X
37	<i>Niltava grandis</i> *	X	X	X	—	X
38	<i>Niltava sundara</i> *	Thailand	X	X	South Yunnan	X
39	<i>Oriolus traillii</i>	X	X	X	?	X
40	<i>Orthotomus atrogularis</i> *	X	X	X	—	X
41	<i>Orthotomus cuculatus</i> *	—	X	X	—	X
42	<i>Orthotomus sutorius</i> *	X	X	X	X	?
43	<i>Paradoxornis atrosuperciliaris</i> *	—	X	—	—	X (Taxonomy?)
44	<i>Paradoxornis nipalensis</i> *	—	X	—	X	X
45	<i>Parus ater</i> *	—	X	—	X	X
46	<i>Parus spilonotus</i> *	?	X	X	X	X
47	<i>Passer montanus</i> *	X	X	X	X	X?
48	<i>Pericrocotus ethologus</i> *	—	X	—	X	X
49	<i>Pericrocotus flammeus</i> *	X	X	X	X	X
50	<i>Pitta sordida</i> *	X	X	X	—	X
51	<i>Pnoepyga pussila</i> *	—	X	—	—	X
52	<i>Pomatorhinus ferruginosus</i> *	—	X	X	—	X
53	<i>Prunella immaculata</i> *	—	—	—	X	X
54	<i>Pycnonotus cafer</i> *	—	X	—	X	X
55	<i>Pycnonotus jocosus</i> *	X	X	—	X	X
56	<i>Pycnonotus xanthorrous</i> *	—	—	—	X	X
57	<i>Rimator malacoptilus</i> *	—	X	—	X	X
58	<i>Sasia ochracea</i> *	X	X	X	X	X
59	<i>Seicercus polioegenus</i> *	—	X	X	X	X
60	<i>Serilophus lunatus</i> *	Thailand	X	X	?	X
61	<i>Sitta formosa</i> *	—	X	—	—	X
62	<i>Stachyris chrysaea</i> *	X	X	X	—	X
63	<i>Tesia olivea</i> *	X	X	—	X	X
64	<i>Yuhina flavicollis</i> *	Shan States	X	—	X	X
65	<i>Yuhina gularis</i> *	—	X	—	X	X
66	<i>Yuhina nigrimenta</i> *	Vietnam	X	—	X	X
67	<i>Yuhina zantholeuca</i> *	X	X	X	—	X
	Total: 67 species	32	61	38	41	67

^aSubspecies occurs in northwest and northern Thailand (Chiang Mai) and Hkakabo Razi region.

^bSubspecies occurs in northeast India (Arunachal Pradesh and/or Assam and/or Himalayan Mountains) and the Hkakabo Razi region.

^cKnown as Tanintharyi in Myanmar. Includes also, in a few instances, Arakan/western Myanmar and Natmataung (Mount Victoria).

^dSubspecies occurs in southwest China (Yunnan) and Hkakabo Razi region.

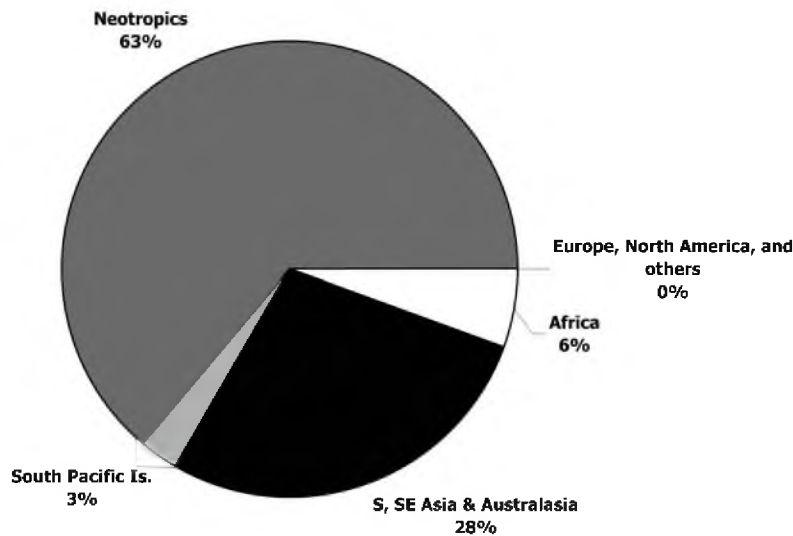


FIG. 1. Global distribution of recently described new avian taxa (2002–2008 inclusive).

Antarctic. In addition, most taxa (global estimate 70%) have been described from mountainous regions, such as the Andes and the Himalayas or from areas with restricted access due to political or security issues. Many areas in the Andes or the greater Himalayan Mountains are restricted for researchers in general. For instance, specific areas in Colombia are controlled by guerillas, and politically sensitive border areas in Myanmar are off-limits to researchers.

On a global scale, most bird taxa were described before 1900, and more than 50% had been described by 1850 (Fig. 2). Since 1950, less than 400 new avian taxa have been described (Fig. 2), and since 2000 around 68 (assuming that all descriptions are valid, genuinely new, and recorded; Peterson 2008). Extrapolating this trend, seven to eight new species can be expected every year. The Neotropics have contributed most of the new bird taxa in recent years; however, if access and active collecting are allowed, other remote regions may have the chance to catch up in the near future (Remsen 1995).

DISCUSSION

Species richness in the southeastern sub-Himalayan mountains is high. Local endemism, elevational turnover, and many overlapping species ranges of marginal distribution contribute to the high species richness. The distributions of 67 species that occur at the centroid of our area

of interest (i.e., the geographic center close to Naung Mung, 35 km northeast-east of Putao), and for which we have sufficient data for this kind of analysis, show that most species found in this area are also found in Arunachal Pradesh and Assam. We also found that many taxa that are quite abundant in Naung Mung are missing from Gaoligong Shan ranges, located just 30 km eastward. This finding indicates that there is a taxon turnover between these two areas. Also, several taxa are endemic to small areas (e.g., *J. naungmungensis* in the Naung Mung area with a probable range <150 km in diameter; Rappole et al. 2008). Hence, endemic species contribute considerably to the analysis.

The southeastern sub-Himalayan mountains, including large parts of Southeast Asia, are globally remarkable: this is one of two areas worldwide (besides the northern Andes in Columbia; Renner and Rappole 2009) where new avian taxa are often described. These new taxa are contributing considerably to the high species richness, and further new descriptions are likely.

Most species ranges are hypothesized, and our own new descriptions from a very small area (Rappole et al. 2005, 2008; Renner et al. 2008, 2009), as well as a revision of taxonomy based on the “missing links” from north Myanmar, indicate that field work in the sub-Himalayan region will probably yield several new taxa and will support the revision of almost all questionable clades from South and Southeast Asia.

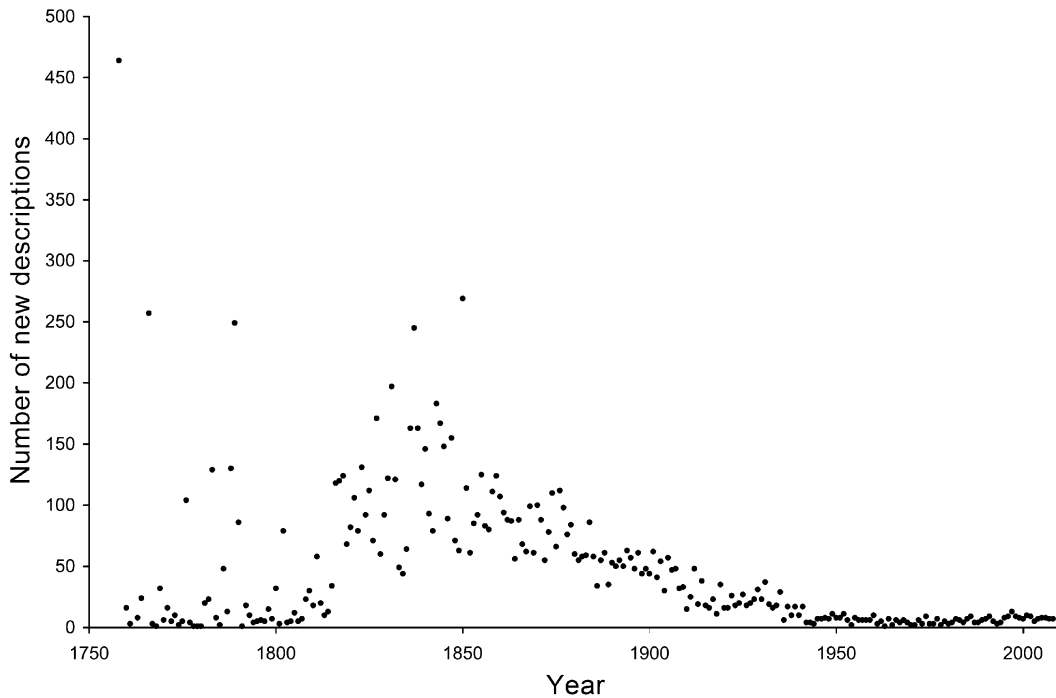


FIG. 2. Descriptions of avian species on the global scale from 1758 until September 2008. Adapted from Peterson (2008).

The largest drawback currently is the large gaps in distributional knowledge and large gaps of specimens—historically or modern sampling—from several parts of the area of interest. Out of 54,328,512 available georeferenced bird records from Global Biodiversity Information Facility (GBIF 2009), only 11,376 occurrences are from within the area of interest (86°E, 22°N to 106°E, 32°N; 200 one-degree cells). Over 60% of these records are from less than 41% of the area of interest—almost 60% of the area has no specimen record at all. (Note: Global Biodiversity Information Facility does not have all records available [GBIF 2009], and many specimen records from European museums are not yet georeferenced.)

ACKNOWLEDGMENTS

First of all, we thank U Thein Aung, U Myint Aung, U Uga, and U Nay Myo Shwe, who have provided extraordinary assistance to us throughout our decade and a half of work in Myanmar. Our thanks are also extended to numerous field assistants, especially U Kyaw Lin, U Tu Myint U, U A Jo, U Myint Kyaw, U Bran Shaung, U San Naing Dee, and far more than 100 helpers, without

whom we never would have collected a single specimen. It is a special honor for us that they also contributed in quite different ways to this monograph. We thank the Nature and Wildlife Conservation Division of the Union of Myanmar Forestry Department, and especially former Director U Khin Maung Zaw, for permission to conduct the study (Myanmar Collection and Export Permit SI/4697/2004). We thank U Aung Khin and Daw Thandar Kyi from Myanmar Gateway Tours as well as U Tay Zah from SST Travel, who organized the expeditions and logistics for us. The Smithsonian Institution, Office of the Undersecretary for Science, provided support for an expedition through the Abbott Fund. Additional support came from the Alexander Wetmore Fund, Bird Division, U.S. National Museum of Natural History (NLMNH), Smithsonian Institution, the National Geographic Society, the Chapman Collection Study Grant (American Museum of Natural History [AMNH], New York), and the European Commission's Research Infrastructure Action via the SYNTHESYS Project. Animal-use activities were cleared by the CRC-IACUC on 3 January 2002 (no. 01-34) and 20 December 2006 (no. 06-27) as a continuation of our avian inventory in Myanmar.

In particular, we thank G. R. Graves, S. L. Olson, J. P. Dean, B. K. Schmidt, and C. M. Milensky, NLMNH; R. Prys-Jones and M. P. Adams, The Natural History Museum, Tring, United Kingdom; D. Willard, Field

Museum of Natural History, Chicago; P. R. Sweet, AMNH; J. V. Remsen, Jr., and S. W. Cardiff, Museum of Natural Science, Louisiana State University (LSUMNS), Baton Rouge; and N. Rice and L. Joseph, Academy of Natural Sciences of Philadelphia (ANSP); J. P. Dumbacher and M. Flannery, California Academy of Sciences, San Francisco (CAS); F. Woog, Staatliches Museum für Naturkunde Stuttgart (SMNS); R. van den Elzen and S. Rick, Zoologisches Forschungsmuseum A. Koenig, Bonn (ZFMK); S. Frahnert, J. Fiebig, and F. Steinheimer at the Humboldt Museum, Berlin; M. Güntert, Naturhistorisches Museum Bern (NMBE); and A. Gamauf, Naturhistorische Sammlungen Wien, Vienna.

Special thanks also to A. P. Peterson, who is organizing the wonderful www.zoonomen.net and providing a fast and excellent taxonomic source for first approximation and orientation on avian species. Even when located in developing countries where most Western-based journals are inaccessible via the Internet and not represented in any library, access is guaranteed almost anywhere. The same is true for the BirdLife International data zone; nevertheless, some of their taxonomy will need revision to reflect scientific findings in taxonomy.

We thank N. J. Collar, J. Pilgrim, C. Robson, and other valued colleagues at various BirdLife International offices for enthusiastic but controversial discussion on some matters discussed herein and acknowledge their disagreement. Nevertheless, we are convinced that they are wrong. Last but not least we would like to thank J. P. Dumbacher and J. C. Eames on comments and opinion on earlier versions and parts of the manuscript, which improved the work considerably.

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