Vol. 4 January 2013
CHED Accredited Research Journal, Category A
Print ISSN 2094-5019 • Electronic ISSN 2244-0461
doi: http://dx.doi.org/10.7828/ajob.v4i1.301

Asian Journal of Biodiversity
Art. #301 pp. 135-168
This Journal is in the Science Master Journal List of
Thomson Reuters (ISI) Zoological Record

# Philippine-endemic and Mindanao-endemic Bird Communities on Canticol and Mt. Hilong-hilong, Philippines

**SHERRYL L. PAZ**
ORCID No. 0000-0002-8465-4997
*sheter29@yahoo.com*
Department of Biology, Caraga State University,
Ampayon, Butuan City, Philippines,

**DUSIT NGOPRASERT**
ORCID No. 0000-0002-2008-4809
*ndusit@gmail.com*
Conservation Ecology Program,
King Mongkut's University of Technology Thonburi,
49 Thakham, Bangkhuntien, Bangkok, Thailand

**OLGA M. NUNEZA**
ORCID No. 0000-0002-7102-9674
*olgamnuneza@yahoo.com*
Department of Biological Sciences,
Mindanao State University-Iligan Institute of Technology,
Tibanga Highway, Iligan City, Philippines

**NEIL ALDRIN D. MALLARI**
ORCID No. 0000-0002-0357-9586
*aldrin.mallari@gmail.com*
Flora and Fauna International,
Silang, Cavite, Philippines

**GEORGE A. GALE**
ORCID No. 0000-0001-6988-1625
*ggkk1990@gmail.com*
Conservation Ecology Program,
King Mongkut's University of Technology Thonburi,
49 Thakham, Bangkhuntien, Bangkok, Thailand

***Abstract*** - The study assessed the Philippine-endemic and Mindanao-endemic bird communities of two mountains in Agusan del Norte – Canticol, Tubay and Mt. Hilong-hilong, Remedios T. Romualdes (RTR) from September to November, 2008 using eight-minute fixed-radius point counts. Habitat variables included vegetation structure, elevation, slope and incidence of anthropogenic disturbance. Non-linear regression analysis and AICc model selection were used to determine the habitat variables that influence the richness and abundance of endemics in the two sites. Canticol had lower mean density of large and medium trees and higher degree of anthropogenic disturbance than Mt. Hilong-hilong. There were 31 Philippine-endemic birds (four threatened) and three Mindanao-endemics (one threatened) on Canticol while there were 39 Philippine-endemics (seven threatened) and six Mindanao-endemics (three threatened) on Mt. Hilong-hilong. The diversity of endemics was significantly higher on Mt. Hilong-hilong (H′=2.31). The study suggests that the two sites need conservation attention to prevent forest loss and endangerment of the threatened endemics. Vegetation structure and elevation had the greatest influence on the endemic bird communities in the two sites. Adequate regeneration of the disturbed sites in the region must also be prioritized as part of a long-term management strategy.

*Keywords* - richness, abundance, habitat, threatened, avian communities

## INTRODUCTION

South-East Asia has the highest relative rate of deforestation which has adversely affected its rich and unique biodiversity (Sodhi et al., 2005). The Philippines exemplifies the dire situation for biodiversity in Southeast Asia (Posa et al., 2006), where the country's remarkably high endemism (Peterson et al., 2000, Peterson 2006) and extensive deforestation and severe loss of natural habitats has made the country a global conservation priority (Myers, 2000). The Philippines as a whole has lost 93% of its forests since 1900 (Onget et al., 2002) and the country ranks second in terms of its annual forest loss in South-East Asia and seventh in the world from 2000 to 2005 (Echanove, 2008). Land use changes such as deforestation, forest fragmentation and agricultural expansion resulting in habitat loss have been identified as major threats to avian biodiversity (Brooks et al., 2002 and Sodhi, 2004). Within the Philippines, Eastern Mindanao has been declared as one of the largest remaining blocks of tropical lowland rainforest (Conservation International, 2008). However, much of the remaining lowland dipterocarp forest is within logging concessions (75% of the country's timber comes from this area) while mining operations proliferate throughout the Eastern Mindanao Biodiversity Corridor (CEPF, 2001).

The Eastern Mindanao Biodiversity Corridor houses 196 bird species of which 91 (46%) are Philippine-endemics which is more than half (51%) of the country's total number of endemic birds and has 22 threatened species (PEF 2008). However, even basic quantitative assessments of habitat and impacts of forest loss and other habitat disturbances on the forest biota such as the Philippine and Mindanao-endemic avifauna have been scarce (Posa et al., 2006). The scarcity of the studies of these endemic bird communities makes it difficult to determine the response of these endemics and other forest inhabitants to various anthropogenic habitat alterations. Hence, in this study, the Philippine-endemic and Mindanao-endemic bird communities were investigated on the two mountains in Agusan del Norte particularly Canticol, Tubay and Mt. Hilong-hilong, RTR which are expected to contain several endemics.

## OBJECTIVES OF THE STUDY

The study was conducted to (1) assess and compare the habitat characteristics of the two sites (2) determine and compare the species richness, abundance, diversity, distribution and the status of the Philippine-endemic and Mindanao-endemic birds of the two sites (3) determine the influence of the various habitat variables on the abundance and richness of the endemics and on the abundance of the various feeding guilds in the two sites and (4) determine the implications of the findings for conservation and land use management.

## MATERIALS AND METHODS

### *Study Areas*

Study sites were located in Canticol in between Tubay and Santiago and on Mt. Hilong-hilong, RTR (Fig. 1). Both of the study areas were situated in Agusandel Norte, Region 13, CARAGA, Mindanao, Philippines. Canticol lies at the northwest of Agusan del Norte (09°13'17.1''N 125°38'47.2''E) facing the municipality of Santiago on its north and Dona Telesfora, Tubay on its south. Canticol is made up of heterogeneous vegetation including grassland (two sampling points), early secondary growth (nine points), advanced secondary growth (12 points) as well as old growth forest (17 points). There has been no documentation of the ecological, geographical and geological profile of Canticol including its flora and fauna. Our habitat classification is based on the dominance of large trees and the unique characteristics of stand structure including tree size, age and spacing of trees and the various stages of succession after logging (Gonzales-Salcedo, 2001). The areas surveyed had an altitude range of 1,030-1,505 m in Canticol.

Mt. Hilong-hilong lies on the boundaries of Agusan del Norte, Agusan del Sur and Surigao del Sur provinces, in the northern portion of the Diwata range of northeast Mindanao (9°06'N 125°43'E) (Birdlife International 2008). The mountain includes mostly montane forests however lowland forests can also be found (Mallari et al., 2001). The climate of Mt. Hilong-hilong is characterized by no pronounced dry season (PEF 2008). Since Mt. Hilong-hilong is too wide to be sampled rapidly, sampling was only done in the RTR section, Agusan del Norte (09°05'20.3' N 125°42'03.2'' E). All of the 44 sample points on Mt. Hilong-hilong were classified as old growth with an elevation range of 1,115-1,810 m.

### *Bird Surveys*

A preliminary survey was conducted in the two study areas during June – August, 2008 to gain familiarity with the habitat characteristics, existing bird species and to establish survey points. A total of four, 2-km lines were established in each study area. Each line was divided into 10-11 sampling points placed every 200 m. There were 40 sampling points on Canticol which covered various habitat types while there were 44 sampling points on Mt. Hilong-hilong which covered only the old growth.

Surveys were conducted in September to November 2008. Eight-minute fixed-radius point counts were used in each study area between 500 to 800 hours when the bird activity was assumed to be highest. Each survey was carried out under similar weather conditions i.e. no strong winds and no heavy rain (Venegas, 2000). At every sampling point, all birds encountered (either seen or heard) within 30-m radius were recorded by the same two observers as above. Upon arrival at the sampling point, an additional minute was allotted for resting before commencing the count. Each point was surveyed twice whereby counts were repeated the following day in reverse order, starting from the farthest end of the line at dawn to minimize bias associated with time of day. Bird species were recorded, and the abundance of birds at each sampling point from the two surveys was summed.

Species richness and similarity of endemic bird communities in the two sites was determined by calculating Sorensen's similarity (abundance-based) using SPADE software (Chao & Shen, 2009). Diversity in each sampling point in the two sites was determined using Species Diversity and Richness Software (Heanderson & Seaby, 2001). Shannon-Wiener index was used to represent the bird species diversity because it is the most commonly used diversity index (Cheng, 1999). Mann-Whitney U tests were used to compare mean differences between the two mountains in the richness, abundance and diversity of the pooled Philippine-endemics and Mindanao-endemics only. Moreover, the endemics were classified according to feeding guilds following Round et al. (2006).

### *Habitat Assessment*

Nine variables were measured including the number of trees >40 cm diameter at breast height (dbh), 21-40 cm dbh, 10-20 cm dbh, percentage of shrubs, percentage of herbs, percentage of bamboo, elevation, slope, and presence/absence (+/-) of disturbance (defined below). Habitat measurements were taken at every sampling point using a modified habitat assessment procedure of Heaney (1986). Vegetation measurements were recorded within 10 m and 20 m radius circular plots. The number of trees within a specific size (dbh) group was quantified in each sampling point using a dbh tape measure. The tree size range that was assessed within 20 m radius circular plots at each sampling point was >40 cm dbh and the tree size ranges that were assessed within the 10 m radius circular plots: 21-40 cm dbh and, 10-20 cm dbh. The percent cover of shrubs, herbs and bamboo were assessed by estimating their percentage cover within a 10-m radius of each sampling point. The elevation of each sampling point was determined using an altimeter. The geographic coordinates of each sampling point were recorded using an etrex Vista HCx Garmin GPS. The degree of slope at the sampling points was determined using a clinometer. The specific type of site disturbance was identified through visual observation and interviews with local people. Presence or absence of disturbance was recorded as 0 = undisturbed and 1 = disturbed. The specific type of forest disturbance (e.g. mining, logging, burning of trees, etc.) was also noted.

Mann-Whitney U-tests were used to test for significant differences between the two sites for all of the above habitat variables. The percentage data (shrubs, herbs and bamboo) was arcsine transformed prior to analysis. We used a Z-test to compare the degree of disturbance (the proportion of sites disturbed) between the two sites (Sheskin, 2000).

### *Habitat models*

Non-linear regression (Poisson family) was used to determine the habitat variables that most influenced the species richness and negative binomial family of non-linear regression to assess the habitat effects on abundance of the Philippine-endemics and Mindanao-endemics.

The habitat and the endemic bird data from Canticol and Mt. Hilong-hilong were pooled for the non-linear regression analysis. Candidate models were defined for the species richness and abundance of the endemics by using Akaike's Information Criterion corrected for small samples (AICc) (Burnham and Anderson, 1998). Explanatory variables were entered into models in the following combinations: (1) each of the individual variables run separately to determine the influence of each individual variable, (2) vegetation variables only, (3) vegetation and topographic variables, and (4) vegetation, topographic and disturbance variables. The top models were evaluated based on the lowest AICc scores and the strength of evidence indicated by the model weights, *wi*(Johnson et al., 2004). We evaluated models by using differences in AICc values, with $\Delta$ AICc<2 indicating nearly equivalent support between models (Burnham and Anderson, 1998). Relative importance weights were determined by summing AIC weights of all models containing each respective variable and comparing these sums proportionally (Burnham and Anderson, 1998).

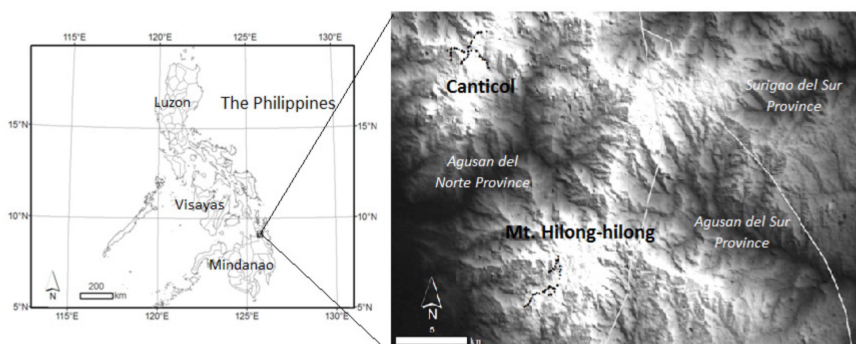


Fig. 1. Map showing the two sampling sites,
Canticol and Mt. Hilong-hilong

## RESULTS AND DISCUSSION

### *Habitat characteristics*

Four of the six vegetation variables tested were significantly different between Canticol and Mt. Hilong-hilong (Table 1). Mt. Hilong-Hilong had significantly higher mean densities of large trees (>40 cm dbh) and medium-sized trees (21-40 cm dbh). There were no trees >160 cm dbh recorded in Canticol.  Mt. Hilong-hilong had significantly greater values for percent herb cover (*P* 0.003) and bamboo (*P* 0.025). In terms of the topographic attributes, Mt. Hilong-hilong was at significantly higher elevation than Canticol. The two sites showed no significant difference in mean density for small diameter trees (10-20 cm dbh), percentage shrub cover and slope. The significantly lower mean value for large trees (>40 cm dbh) and medium trees (20-40 cm dbh), the absence of  >160 cm dbh trees in Canticol and the disturbance index implied recent tree extraction and that more sites were in early stages of regeneration and generally more disturbed relative to Mt. Hilong-hilong. The variability of the vegetation characteristics between Canticol and Mt. Hilong-hilong can be attributed to the varying topographic characteristics and types and extent of anthropogenic disturbances in the two sites.

Moreover, Canticol is significantly lower in elevation compared to that of Mt. Hilong-hilong making it more accessible to local people which is especially important as this is a mineral-rich area. Hence, the results revealed that there was a significantly lower incidence of disturbed points on Mt. Hilong-hilong than on Canticol (Table 1). The anthropogenic disturbances (70% of the points) identified in Canticol included small-scale gold mining operations such as tunneling and gold panning, cutting of trees for mining tunnels, firewood and for houses of the miners and bird hunting.

The increasing human population on Canticol if not given due attention, would most likely increase the level of tree extraction in the remaining forest especially the advanced secondary growth and the old growth. Additionally, the people in the area were also observed resorting to bird hunting for food (D. Abrinica pers. comm. 2008). This might eventually harm the bird community as well as the habitat for other forms of wildlife.

On the other hand, Mt. Hilong-hilong is explicitly more well-known than Canticol. Aside from being the largest block of the country's remaining dipterocarp forests and one of the important bird areas in the country, it is also part of the Eastern Mindanao Biodiversity Corridor and it is one of the priority biodiversity conservation areas in the Philippines (PEF 2008). Although Senate Bill 1066 declaring Mt. Hilong-hilong as a protected area is pending (DENR-Caraga unpublished), restrictive management has been imposed by the Department of Environment and Natural Resources-Caraga in the said area. Hence, only very minimal anthropogenic disturbance (39% of the sampling points) was observed such as abaca stripping (due to abundant wild abacca on the lower montane areas), rattan collection and selective tree cutting to provide the locals with firewood and housing materials. Moreover, the inaccessibility of Mt. Hilong-hilong probably also accounts for the lesser anthropogenic pressures in the area including the absence of large-scale logging or small-scale mining activities.

Table 1. Untransformed (means ± standard deviations) habitat characteristic measures in Canticol (n = 40 sampling points) and Mt. Hilong-hilong (n = 44 sampling points), September–November, 2008

| Habitat Variables | Canticol | Mt. Hilong-hilong | Mann-Whitney (*P*) |
|---|---|---|---|
| >40 cm dbh trees | 5.3±5.0 | 11.5 ± 7.2 | <0.001 |
| 21-40 cm dbh trees | 7.8 ± 5.9 | 21.3±10.3 | <0.001 |
| 10-20 cm dbh trees | 15.6± 10.6 | 16.1± 10.2 | 0.736 |
| Shrubs (%) | 55.8 ± 11.1 | 54.1 ± 10.9 | 0.791 |
| Herbs (%) | 38.2 ± 10.8 | 47.0 ± 12.1 | 0.003 |
| Bamboo (%) | 8.8 ±16.2 | 9.6 ± 9.3 | 0.025 |
| Elevation (m) | 1248.8 ± 156.1 | 1353.6 ± 173.3 | 0.007 |
| Slope (degree) | 27.1 ± 12.0 | 28.3 ± 7.7 | 0.774 |
| Incidence of disturbance | 28/40 = 70% | 17/44 = 38.6% | 0.004[a] |

[a] Test for comparing two proportions Z = 2.87

### *Bird Community*

Canticol and Mt.Hilong-hilong had a total of 51 endemics of which 43 were Philippine-endemics and eight were Mindanao-endemics (Table 2). There were a total of 733 individuals detected on Canticol of which, 674 detections were Philippine-endemics and 59 were Mindanao-endemics and there were a total of 830 individuals detected on Mt. hilong-hilong of which,657 detections were Philippine-endemics and 173 detections were Mindanao-endemics. Using abundance-based Sorensen's index, the similarity of the endemic bird communities in the two sites was 94.6% with 28 bird species shared between the two sites with a lower estimated number of endemic species on Canticol (Chao1= 37 ±2.5 species, 95% CI: 35.3–48.3 species) than Mt. Hilong-Hilong (Chao1 = 47 ±2.6 species 95% Cl: 45.3–59.4), although the difference was not statistically significant.

There were three species of near-threatened Philippine-endemic birds, one near-threatened Mindanao-endemic and one vulnerable Philippine-endemic on Canticol. On Mt. Hilong-hilong, there were three near-threatened Philippine-endemics, two near-threatened Mindanao-endemics, three vulnerable Philippine-endemics, onevulnerable Mindanao-endemic, and one endangered Mindanao endemic observed (Table 2). *Buceros hydrocorax* (0.54%) had the highest relative abundance among the threatened Philippine-endemics on Canticol, and there was only one observation of the threatened Mindanao endemic, *Otusmirus* (0.14%) on Canticol. *Buceros hydrocorax* (2.2%) had the highest relative abundance among the threatened Philippine-endemics while *Phapitreron brunneiceps* (0.84%) had the highest

Table 2. List of Philippine- endemic and Mindanao-endemic bird species recorded, number of individuals, habitat types and feeding guilds on Canticol and Mt. Hilong-hilong during September to November 2008.

| Scientific Names | **Feeding Guild** (Round et al,. 2006) | IUCN, 2011 Category | Number of Individuals | Canticol Relative Abundance % | Habitat Type | Number of Individuals | Mt. Hilong-hilong Relative Abundance % | Habitat Type |
|---|---|---|---|---|---|---|---|---|
| ***Aethopyga boltoni***[a] Mearns 1905 | insectivore/nectarivore | NT | 0 | 0 | - | 1 | 0.12 | OG |
| *Aethopyga pulcherrima*[b] Sharpe 1876 | insectivore/nectarivore | LC | 13 | 1.80 | EESG,ASG,OG | 14 | 1.70 | OG |
| *Aethopyga shelleyi*[b] Sharpe 1876 | insectivore/nectarivore | LC | 3 | 0.41 | ESG,OG | 5 | 0.60 | OG |
| *Arachnothera clarae*[b] Blasius 1890 | insectivore/nectarivore | LC | 0 | 0 | - | 4 | 0.48 | OG |
| *Bradypterus caudatus*[b] Ogilvie-Grant 1895 | insectivore | LC | 1 | 0.14 | ESG | 0 | 0 | - |
| *Buceros hydrocorax*[b] Linnaeus 1766 | arboreal frugivore | NT | 4 | 0.54 | ASG,OG | 18 | 2.20 | OG |
| *Centropus melanops*[b] Lesson 1830 | terrestrial feeder | LC | 5 | 0.68 | ESG,ASG,OG | 6 | 0.72 | OG |
| *Centropus viridis*[b] Scopoli 1786 | terrestrial feeder | LC | 2 | 0.27 | ASG | 0 | 0 | 0 |
| *Collocalia troglodytes*[b] G.R. Gray 1845 | insectivore | LC | 24 | 3.30 | ESG,ASG,OG | 33 | 4.00 | OG |

Table 2 continued

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Dendrocopos maculatus*[b] Scopoli 1786 | insectivore | LC | 0 | 0 | - | 6 | 0.72 | OG |
| *Dicaeum anthonyi*[b] McGregor 1914 | arboreal frugivore | NT | 2 | 0.27 | ASG | 8 | 0.96 | OG |
| *Dicaeum australe*[b] Hermann 1783 | arboreal frugivore | LC | 14 | 1.90 | ESG,ASG,OG | 15 | 1.80 | OG |
| *Dicaeum bicolor*[b] Bourns & Worcester 1894 | arboreal frugivore | LC | 10 | 1.40 | ESG,ASG,OG | 14 | 1.70 | OG |
| *DicaeumHypoleucum*[b] Sharpe 1876 | arboreal frugivore | LC | 14 | 1.90 | ESG,ASG,OG | 6 | 0.72 | OG |
| *Dicaeum nigrilore*[b] Hartert 1904 | arboreal frugivore | LC | 2 | 0.27 | OG | 0 | 0 | - |
| *Dicaeum pygmaeum*[b] Kittlitz 1833 | arboreal frugivore | LC | 16 | 2.2 | GRL,ESG,ASG,OG | 19 | 2.30 | OG |
| *Ducula carola*[b] Bonaparte 1854 | arboreal frugivore | V | 0 | 0 | - | 7 | 0.84 | OG |
| *Ducula poliocephala*[b] Gray 1844 | arboreal frugivore | NT | 0 | 0 | - | 5 | 0.60 | OG |
| *Ficedula basilanica*[b] Sharpe 1877 | sallying insectivore | V | 0 | 0 | - | 2 | 0.24 | OG |
| *Gallicolumba crinigera*[a] Pucheran 1853 | terrestrial feeder | V | 0 | 0 | - | 1 | 0.12 | OG |
| *Harpactes ardens*[b] Temminck 1826 | insectivore | LC | 5 | 0.68 | ASG, OG | 4 | 0.48 | OG |
| *Hypocryptadius cinnamomeus*[a] Hartert 1903 | insectivore | LC | 30 | 4.10 | ESG,ASG,OG | 106 | 12.80 | OG |
| *Hypsipetes everetti*[b] Tweeddale 1877 | arboreal frugivore | LC | 13 | 1.80 | ESG,ASG,OG | 2 | 0.24 | OG |

Table 2 continued

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Hypothymis helenae*[b] Steere 1890 | sallying insectivore | NT | 1 | 0.14 | ASG | 0 | 0 | - |
| *Hypsipetes philippinus*[b] Forster 1795 | arboreal frugivore | LC | 69 | 9.40 | GRL,ESG,ASG,OG | 81 | 9.80 | OG |
| *Lophozosterops goodfellowi*[a] Hartert 1903 | arboreal frugivore | LC | 28 | 3.80 | ESG,ASG,OG | 54 | 6.50 | OG |
| *Loriculus philippensis*[b] Muller 1776 | arboreal frugivore | LC | 1 | 0.14 | ASG | 0 | 0 | - |
| *Macronous striaticeps*[b] Sharpe 1877 | insectivore | LC | 198 | 26.9 | ESG,ASG,OG | 80 | 9.60 | OG |
| *Otus mirus*[a] Ripley &Rabor 1968 | raptor | NT | 1 | 0.14 | OG | 0 | 0 | - |
| *Pachycephala albiventris*[b] Ogilvie-Grant 1894 | insectivore | LC | 0 | 0 | - | 2 | 0.24 | OG |
| *Parus elegans*[b] Lesson 1831 | insectivore | LC | 185 | 25.10 | ESG,ASG,OG | 113 | 13.60 | OG |
| *Pachycephala homeyeri*[b] Blasius 1890 | insectivore | LC | 0 | 0 | - | 1 | 0.12 | OG |
| *Pachycephala philippinensis*[b] Walkden 1872 | insectivore | LC | 9 | 1.20 | ESG,ASG,OG | 11 | 1.30 | OG |
| *Penelopides affinis*[a] Tweeddale 1877 | arboreal frugivore | E | 0 | 0 | - | 4 | 0.48 | OG |
| *Phapitreron amethystine*[b] Bonaparte 1855 | arboreal frugivore | LC | 6 | 0.81 | ESG,ASG,OG | 7 | 0.84 | OG |
| *Phapitreron brunneiceps*[a] Bourns & Worcester 1894 | arboreal frugivore | E | 0 | 0 | - | 7 | 0.84 | OG |
| *Phapitreron leucotis*[b] Temminck 1823 | arboreal frugivore | LC | 8 | 1.10 | ESG,ASG | 24 | 2.90 | OG |

Table 2 continued

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Phylloscopus olivaceus*[b] Moseley 1891 | insectivore | LC | 38 | 5.20 | ESG,ASG,OG | 28 | 3.40 | OG |
| *Prioniturus discurus*[b] Vieillot 1822 | arboreal frugivore | LC | 10 | 1.4 | ESG,ASG,OG | 52 | 6.30 | OG |
| *Ptilinopus leclancheri*[b] Bonaparte 1855 | arboreal frugivore | LC | 0 | 0 | 0 | 3 | 0.36 | OG |
| *Ptilocichla mindanensis*[b] Blasius 1890 | insectivore | LC | 2 | 0.27 | ESG,OG | 9 | 1.10 | OG |
| *Ptilinopus occipitalis*[b] Gray and Mitchell 1844 | arboreal frugivore | LC | 7 | 0.95 | ASG, OG | 7 | 0.84 | OG |
| *Pyrrhula leucogenis*[b] Ogilvie-Grant 1895 | arboreal frugivore | LC | 0 | 0 | - | 1 | 0.12 | OG |
| *Rhinomyias goodfellowi*[a] Ogilvie-Grant 1905 | sallying insectivore | NT | 0 | 0 | 0 | 4 | 0.48 | OG |
| *Rhabdornis inornatus*[b] Ogilvie-Grant 1896 | arboreal insectivore/fru-givore | LC | 0 | 0 | 0 | 4 | 0.48 | OG |
| *Rhabdornis mystacalis*[b] Temminck 1825 | insectivore | LC | 2 | 0.27 | ASG | 2 | 0.24 | OG |
| *Rhipidura nigrocinnamomea*[b] Hartert 1903 | arboreal insectivore/fru-givore | LC | 0 | 0 | 0 | 6 | 0.72 | OG |
| *Rhipidura superciliaris*[b] Sharpe 1877 | insectivore | LC | 7 | 0.95 | OG | 14 | 1.70 | OG |
| *Sarcops calvus*[b] Linnaeus 1876 | arboreal insectivore/ frugivore | LC | 2 | 0.27 | ASG | 4 | 0.48 | OG |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Spizaetus philippensis***[b] Gould 1863 | Raptor | V | 1 | 0.14 | ASG | 3 | 0.36 | OG |
| *Stachyris capitalis*[b] Tweddale 1877 | insectivore | LC | 0 | 0 | - | 17 | 2.04 | OG |
| **Total** | | | 733 | 100 | | 830 | 100 | |
| **Total # of endemic species of the two sites** = 52 (7[a] and 45[b]) **Total # of threatened endemics of the two sites** = 14 (**Canticol** = 4 NT (8 ind); 2 V (5 ind) ; **Mt. Hilong-hilong** = 5 NT (36 ind.), 4 V (13 ind) , 2 E (11 ind) | | | | | | | | |

[a]*Mindanao-endemic;* [b]*Philippine-endemic* (those in bold are threatened endemics)

ESG – Early Secondary Growth
OG - Old Growth
E - Endangered
NT – Near threatened
V- Vulnerable
LC – Least concern
ASG – Advanced Secondary Growth

relative abundance among the threatened Mindanao-endemics on Mt. Hilong-hilong. It was also found that there were more species and individuals of threatened endemics on Mt. Hilong-hilong (10 species with 55 individuals) than on Canticol (five species with 7 individuals).

There was a total of 57 species including non-endemics, 45 genera, 21 families and 11 orders of birds with a total of 1,155 detections recorded on Canticol. There were 31 species (54.4%) of Philippine endemics, three species (5.3%) of Mindanao endemics, and 23 species (40.4%) were not endemics. Among the non-endemic birds, 19 species were resident breeders, one species was a resident migrant and three species were migrants or winter visitors (Fig. 2).

On the other hand, 82 bird species belonging to 57 genera, 31 families and 10 orders with a total 1,205 individual detections were recorded on Mt. Hilong-hilong. Of the total species encountered on Mt. Hilong-hilong, 39 species (47.6%) were Philippine-endemics, six species (7.3%) were Mindanao-endemics, and 37 species (45.1%) were non-endemics. Among the non-endemics, 35 species were resident-breeders and two species were migrants. There were no resident-migrant species recorded during the study in this area.

The species richness and abundance of endemics per sample point on Mt. Hilong-hilong was not different from Canticol (Mann-Whitney U = 876.5, 861.5, $P = 0.89, 0.97$ respectively). However, the diversity per point on Mt. Hilong-Hilong (mean 2.83 ± SE 0.05) was significantly higher than on Canticol (mean 2.31 ± SE 0.04) (Mann-Whitney U = 156.5, $P<0.001$).The significantly lower diversity of endemics in Canticol could be explained by its higher incidence of anthropogenic disturbance (70%). The identified disturbances in Canticol are forms of biomass extraction which may cause significant changes in forest structure and plant composition (Sagar & Singh, 2004) which in turn may affect species composition of endemic avifauna and lower bird diversity in disturbed sites (Shahabuddin & Kumar, 2006). Birds with small geographical ranges have been shown to decline in abundance following disturbance more significantly than other groups (Gray et al., 2007) and island-endemic birds are thought to seldom use disturbed habitats due to their evolved morphological and behavioral characteristics resulting in their specialized preference for specific natural forest resources (Blonde, 2000). Habitat disturbances in Canticol might adversely affect the vegetation structure, which in turn affect the diversity of endemic birds by reducing overall habitat quality and food availability. For example in Sri Linka, Wijesinghe and Brook (2005) indicated that endemic species had a distinct preference for the less disturbed forest while the non-endemic species manifested greater ability to utilize human-modified habitats. The significantly higher density of large trees >40 cm dbh may have perhaps contributed to the complexity of the vegetation structure on Mt. Hilong-hilong which according to Leito et al. (2006), can increase niche diversity of birds. The results indicate the need to regularly monitor the level of disturbance on Canticol and Mt. Hilong-hilong. Moreover, the sensitivity of the endemic birds to the specific type and extent of the habitat disturbance needs be investigated further.

Forest species and many specialist endemic species with high conservation priority are highly intolerant of disturbance (Martin & Blackburn, 2010). In this study, Canticol had higher richness and abundance of threatened endemics than Mt. Hilong-hilong and it was found that most of the threatened endemics were observed in the advanced secondary and old growth forests in both sites. Likewise, in Karakelang, Talaud Islands, Indonesia, Riley (2003) found that all endemic and threatened birds occurred at higher densities in primary forests suggesting the need for conservation efforts on these areas. According to Posa (2006), knowing that forest disturbance negatively affects endemics, preserving mature forests should be the primary concern of Philippine conservation efforts. A huge part of this tropical landscape is already degraded and now requires urgent actions for the mitigation of human impacts on tropical forest birds as well as other groups of organisms (Sodhi et al., 2008).

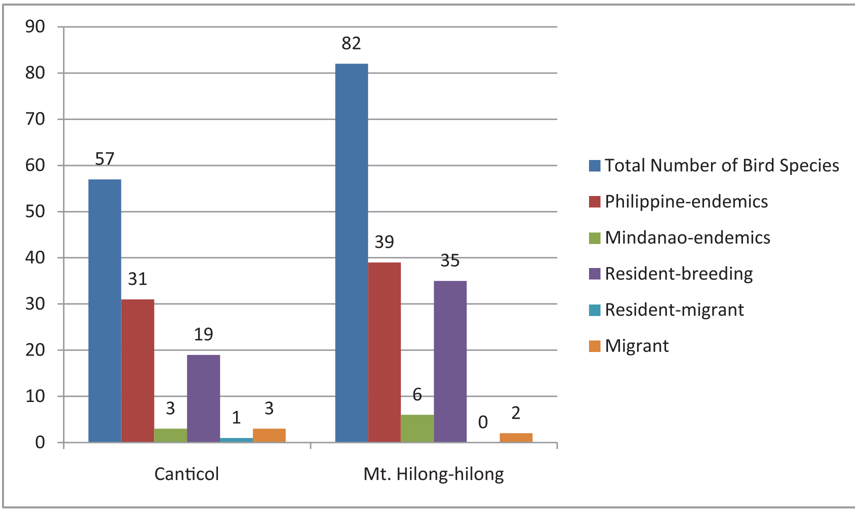


Fig.2. Bird community measures (total number of species, number of Philippine-endemics, Mindanao-endemics and the non-endemics) of Canticol and Mt. Hilong-hilong

### *Habitat Selection Models*

Model selection indicated that the best models included elevation and trees >40 cm dbh suggesting that increasing number of large trees was associated with increased species richness and abundance while increasing elevation was associated with decreasing richness of endemic birds (Table 3 & 4). Based on AIC weights, elevation had the highest relative importance with regards to the species richness of endemic birds while number of trees (10-20 cm dbh) and (>40 cm dbh) had the highest weights respectively in regards to endemic bird abundance.

Table 3. Non-linear regression models of habitat attributes influencing the species richness and abundance of Philippine-endemic and Mindanao-endemic birds of the two mountains, Canticol and Mt. Hilong-hilong

| **Species richness' models** | **Δ AICc** | $w_i$ |
|---|---|---|
| Y = β0 + 0.20 (>40 cm dbh) – 2.04(elev) | 0.00 | 0.22 |
| Y = β0 – 0.07(shr)+ 0.48(her) + 0.35(bam) – 1.51(elev) | 1.47 | 0.10 |
| Y = β0 – 0.07(shr)+ 0.38(her) + 0.52(bam) | 1.51 | 0.10 |
| Y = β0 + 0.20(>40 cm dbh) – 2.0(elev) + 0.13(slop) | 1.84 | 0.09 |
| Y = β0 -0.26(shr) + 2.58 (her) + 1.61 (bam) – 7.68(elev) + 0.59(10-20 cm dbh) | 2.06 | 0.08 |
| Y = β0 – 0.08(shr) + 0.39(her) + 0.46(bam) + 0.12(10-20 cm dbh) | 2.24 | 0.07 |
| Y = β0 – 0.21(dist) + 0.17(10-20 cm dbh) | 2.33 | 0.07 |
| Y = β0 - 0.01(shr) + 0.46 (her) + 0.82 (bam) – 1.82 (elev) -0.16 (dist) | 2.35 | 0.07 |
| Y = β0 + 0.01(shr)+ 0.48 (her) + 0.13 (bam) + 0.14 (10-20 cm dbh)–1.92(elev) – 0.18 (dist) | 3.34 | 0.04 |
| Y = β0 - 0.22(dist) | 3.34 | 0.04 |
| Y = β0 + 0.20 (>40 cm dbh) | 3.37 | 0.04 |
| **Abundance' models** | | |
| Y = β0 + 0.45( >40 cm dbh) | 0.00 | 0.29 |
| Y = β0 + 0.35(10-20 cm dbh) | 0.82 | 0.19 |
| Y = β0 + 0.45(>40 cm dbh) - 0.95(elev) | 1.64 | 0.13 |
| Y = β0 - 0.17(dist) + 0.36(10-20 cm dbh) | 2.07 | 0.10 |
| Y = β0 - 0.41(shr)+ 0.35(10-20 cm dbh) | 2.35 | 0.09 |
| Y = β0 - 0.40(shr)+ 0.63(her) + 0.35(10-20 cm dbh) | 2.98 | 0.07 |
| Y = β0 + 0.45(>40 cm dbh) -1.03(elev) -0.1(slop) | 3.78 | 0.04 |
| Y = β0 - (shr)+ (her) + (bam) + (10-20 cm dbh) | 4.04 | 0.04 |

dbh = diameter breast height; elev = elevation; shr = shrubs; her = herbs; bam = bamboo; slop = slope ; dist = disturbance)

Results imply that the community structure of Philippine-endemic birds on Canticol and Mt. Hilong-hilong is influenced by vegetation structure and elevation. Results suggested that as the number of large trees increased, richness of Philippine-endemics also increased. Large trees may also provide a variety of resources for birds such as arthropods in bark, dead woody tissues and in the dense epiphytic layer that covers most of the tall branches (Sillett, 1994) as well as their flowers and fruits. While understory structure (shrub, herb, and bamboo cover) was positively associated with species richness and abundance as shown elsewhere (Reid et al.,2004; Chettri et al., 2005; Scott et al., 2005). The disappearance of the undergrowth vegetation due to clearing and disturbance can result in significant habitat limitations for birds (Camprodon & Brotons, 2006). This suggests the importance of trees in structuring forest habitats and in providing trophic resources such that the combination of both large and small tree class sizes along with a complex understory may produce increased foliage height diversity, diverse microhabitats and niches, higher overall resource availability and shelter from weather and predators that cater to the greatest number of species and a greater abundance of endemic birds (MacArthur and MacArthur, 1961; Hildén, 1965; Hulbert, 2004; and Kessler et al., 2005).

It was also found that increasing elevation was associated with decreasing species richness which corroborates with studies of Terborgh (1971, 1977) and Kattan & Franco (2004). Declines in forest area, abundance of invertebrates, changes in environmental conditions, extent of competition, types of resources and community composition at increasing elevations can explain declines in species richness (Terborgh, 1971; Beehler, 1981; Janes 1994; Blake & Loiselle, 2000). Towards higher elevations, the height of woody vegetation decreases which can reduce the extent of vertical stratification of vegetation structure which most likely reduce the diversity of microhabitats available to birds (Klosius, 2008). Likewise, Goerck (1999) found that the forests at lower elevations were structurally more complex and more diverse in plant species than those along the slopes and at higher elevations and the structurally more complex forest at low elevations along the Atlantic forest of Brazil contained the most diverse avifauna, including several of the rarest and most threatened species.

Table 4. Summary of relative importance weight of eight variables influencing the species richness and abundance of Philippine and Mindanao-endemic birds of the two mountains, Canticol and Mt. Hilong-hilong

| Parameters | Richness | Abundance |
|---|---|---|
| >40 cm dbh trees | 0.35 | **0.46** |
| 10-20 cm dbh trees | 0.33 | **0.48** |
| Shrubs | 0.50 | 0.19 |
| Herbs | 0.49 | 0.10 |
| Bamboo | 0.46 | 0.04 |
| Slope | 0.09 | 0.04 |
| Elevation | **0.60** | 0.17 |
| Disturbance | 0.22 | 0.10 |

## CONCLUSION

The presence of the threatened Philippine-endemic and Mindanao-endemic birds in Canticol and Mt. Hilong-hilong indicates the conservation value of both areas. The study revealed that vegetation structure and elevation influence the endemic bird communities in the two sites. Canticol which was found to have significantly higher incidence of anthropogenic disturbance still houses five threatened Philippine-endemics and one threatened Mindanao-endemic and therefore, needs conservation attention to prevent loss of forest cover and threatened endemics. Equally important, adequate regeneration of the disturbed sites in the region must also be prioritized as part of a long-term management strategy.

## RECOMMENDATIONS

This survey may be considered a baseline study on Philippine-endemic and Mindanao-endemic birds which could be used for more specific and more intensive bird-habitat studies in the CARAGA region and in the country. Understanding the effects of forest habitat heterogeneity and structural complexity on different guilds of endemic birds and specialized habitat choice, specific sensitivity and tolerance of the threatened endemics to various disturbances may help facilitate the formulation of a more robust conservation management plan.

## ACKNOWLEDGMENTS

We would like to thank the Commission on Higher Education, Philippines which provided financial assistance through Mindanao State University-Iligan Institute of Technology. Thanks also to Mr. Renato Fernandez for his big help in identifying the birds and bird calls in the study areas and the Local Government Units of RTR and Tubay, Agusan del Norte, Philippines for the logistical support during the field sampling.

## LITERATURE CITED

Beehler, B.
1981 Ecological structuring of forest bird communities in New Guinea. *Monographiae Biologicae* 42: 837-861.

Birdlife International
2008 *Philippine forests. Working together for birds and people*.http://www.birdlife.org/action/science/species/asia_strategy/forests.html.

Blake, J.G. and B.A.Loiselle
2000 Diversity of Birds along an elevational gradient in the Cordillera Central, Costa Rica. *The Auk* 117: 663-686.

Blonde, J.
2000 Evolution and Ecology of birds on islands: trends and prospects *Vie et Millieu* 50: 205-220.

Brooks, T., S.L. Pimm, N.J. Collar
2002 Deforestation predicts the number of threatened birds in Insular Southeast Asia. *Conservation Biology* 11: 382-394.

Burnham, K.P. and D.R. Anderson
1998 *Model Selection and Interference : A Practical Information-theoretic Approach*. Springer, New York, USA.

Camprodon, J.C. and L.Brotons
2006 Effects of undergrowth clearing on bird communities of the Northwestern Mediterranean Coppice Holm oak forests. *Forest Ecology and Management* 221:72-82.

CEPF
2001 *EcosystemProfileofthePhilippines* http://www.cepf.net/Documents/final.philippines.ep.pdf.

Chao, A. and T.J.Shen
2009 *SPADE*. http://chao.stat.nthu.edu.tw/.

Cheng, C.C.
1999 Monitoring of Forest Landscape Change. *Taiwan Journal for Science* 14: 493-507.

Chettri, N., D.C Deb, E.Sharma, R. Jackson
2005 The Relationship between Bird Communities and Habitat A Study Along a Trekking Corridor in the Sikkim Himalaya *Mountain Research Development* 25: 235-243.

Conservation International
2008 *Eastern Mindanao* http://www.conservation.org/explore/regions/asiapacific/philippines/Pages/eastern_mindanao.aspx.

Echanove, J.
2008 *Forests in Asia: Trends and challenges*. Haring Ibon Issue No. 35. Reprinted from EU News 6 (2).

Goerck, J. M.
1999 BirdLife International in Brazil.BirdLife.Brazil Program. Unpublished draft supplied by author.

Gonzales-Salcedo, P. V.
2001 Floral diversity and vegetation zones of the northern slope of Province Luzon, Philippines. *Asia Life Sciences* 10:119-157.

Gray, M.A., S.L.Baldauf, P.J.Mayhew, J.K. Hill
2007 The Response of Avian Feeding Guilds to Tropical Forest Disturbance. *Conservation Biology* 21: 133–141.

Heanderson&Seaby
2001 *Species Diversity and Richness Version 2.65*. Pisces Conservation Ltd, IRC House, Pennington, UK.

Heaney L.R.
1986 Biogeography of the mammals of Southeast Asia: estimates of rates of colonisation, extinction, and speciation. *Biol. Soc. Linn. Soc*. 28: 127–165.

Hildén O.
1965 Habitat selection in birds: a review. *Annales Zoologici Fennici* 2: 54-75.

Hulbert A. H.
2004 Species-energy relationships and habitat complexity in bird communities. *Ecology Letters* 7: 714 - 720.

Janes, S.W.
1994 Variation in the species competition and mean body size of an avian foliage gleaning guild along an elevationalgradient: correlation with arthropod body size. *Oecologia* 98: 369-378.

Johnson, J.B. &K.S.Omland
2004 Model Selection in Ecology and Evolution. *Trends in Ecology and Evolution* 19: 101-118.

Kattan, G.H., P. Franco
2004 Bird diversity along elevational gradients in the Andes of Colombia: area and mass effects. *Global Ecology and Biogeography* 13: 451–458.

Kessler, M., P.J.A.Kessler, S.R.Gradstein, K.Bach, M. Schmull and R.Pitopang
2005 Tree Diversity in primary forest and different land use systems in Central Sulawesi, Indonesia. *Biodiversity and Conservation* 14: 547-560.

Klosius, H.
2008 Species richness and composition of bird assemblages along an elevational gradient in the Eastern Alps (National Park Gesäuse, Austria). Universitat Wein (unpublished thesis).

Leito, A, J. Truu, E.Roosaluste, K. Seep, andL.Podier
2006 Long term dynamics of breeding birds in broad-leaved deciduous forest on Hanckasti Island in the West-Estonian archipelago. *Ornis, Fennica* 83:124-130.

Mallari, N.A.D., B.R. Tabaranza, and M.J. Crosby
2001 *Key Conservation Sites in the Philippines*. Bookmark, Inc.: Philippines p. 485.

Martin, T.E and G.A.Blackburn
2010 Impacts of Tropical Forest Disturbance Upon Avifauna on a Small Island with High Endemism: Implication for Conservation. *Conservation and Society* 8(2): 127-139.

MacArthur R. H. and J. W.MacArthur
1961 On bird species diversity. *Ecology* 42: 594-598.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B., Kent, J.
2000 Biodiversity hotspots for conservation priorities. *Nature* 403: 853–858.

Ong, P.S.,L.E.Afuang, R.G. Rosell-Ambal
2002 *Philippine Biodiversity Conservation Priorities: A second iteration of the national biodiversity strategy and national plan*. Department of Environment and Natural Resources, Protected Areas and

Wildlife Bureau, Conservation International-Philippines, Biodiversity Conservation Program, UP Center for Integrative and Development Studies and Foundation for the Philippine Environment, Quezon City, Philippines p. 113.

Peterson, AT., L.G.Ball, K.W. Brady
2000 Distribution of the birds of the Philippines: biogeography and conservation priorities. *Bird Conservation International* 10: 149–167.

Peterson, A.T.
2006 Taxonomy *is* important in conservation: a preliminary reassessment of Philippine species-level bird taxonomy. *Bird Conservation International* 16: 155–173.

Philippine Eagle Foundation, Conservation International-Philippines, Department of Environment and Natural Resources
2008 *Eastern Mindanao Biodiversity Corridor Conservation Framework*. Davao City, Philippines.

Posa, M.C. and N.S. Sodhi
2006 Effects of anthropogenic land use on forest birds and butterflies in Subic Bay, Philippines. *Biological Conservation* 129: 256-270.

Reid,S., I.A.Diaz,J.J.Arnesto, M.F. Wilson
2004 The Importance of Native Bamboo for understorey birds in Chilean temperate forests. *The Auk.*121: 515-525.

Riley, J.
2003 Population size and the conservation status of endemic and restricted-range bird species on Karakelang, Talaud Islands, Indonesia. *Bird Conservation International* 13:59-74.

Round, P.D., G,A.Gale, W.Y.Brockelman
2006 A comparison of bird communities in mixed fruit orchards and natural forest at KhaoLuang, southern Thailand. *Biodiversity and Conservation* 00: 1–19.

Sagar, R. And J.S.Singh
2004 Local plant species depletion in a tropical dry deciduous forest of northern India. Environ. *Conservation* 31: 55-62.

Scott, D.M., D.Brown, S.Mahood, B.Denton, A.Silburn, F. Rakotondraparany
2005 The impacts of forest clearance on lizard, small mammal and bird communities in the arid spiny forest, southern Madagascar. *Biological Conservation* 127: 72-87.

Shahabuddin, G. and R.Kumar
2006 Influence of anthropogenic disturbance on bird communities in a tropical dry forest: role of vegetation structure. *Animal Conservation* 9: 404-413.

Sheskin, D.J.
2000 *Handbook of Parametric and nonparametric Statistical Procedures*. Second Ed. Chapman & Hall CRC, New York: USA. p. 982.

Sillet, T.S.
1994 Foraging ecology of epiphyte-searching insectivorous birds in Costa Rica. *Condor* 96: 863-877.

Sodhi, N.S., L.H.Liow, F.A. Bazzaz
2004 Avian Extinctions from tropical and subtropical forests. *Annual Review of Ecology, Evolution and Systematics* 35: 323-345.

Sodhi, N.S., L.P.Koh, D.M.Prawiradilaga, Darjono, I.,Tinulele, D.D.Putra, T.H.T. Tan
2005 Land use and conservation value for forest bird in Central Sulawesi (Indonesia). *Biological Conservation* 122: 547–558.

Sodhi, N.S., G., M.Acciaioli, Erb&A. K.-J.Tan
2008 *Biodiversity and human livelihoods in protected areas: case studies from the Malay Archipelago*. Cambridge University Press, Cambridge, UK. p. 478.

Terborgh, J.
1971 Distribution on environmental gradients; theory and a preliminary interpretation of distributional patterns in the avifauna of the Cordillera Vilcabamba, Peru. *Ecology* 53: 23–40.

Terborgh, J.
1977 Bird species diversity of an Andean elevational gradient. *Ecology* 58: 1007–1019.

Venegas C.
2000 Avifauna de unbosque de lenga (Nothofaguspumilio) intervenido y de uno no intervenido en Magallanes continental, Chile. AnalesdelInstituto de la Patagonia, *Serie Ciencias Naturales* 28: 101–106.

Wijesinghe, M.R., M.D. Brooke
2005 Impact of habitat disturbance on the distribution of endemic species of small mammals and birds in a tropical rain forest in Sri Lanka. *Journal of Tropical Ecology* 21: 661–668.

Fig. 3. Panoramic View of Canticol, Tubay, Agusan del Norte.

Fig. 4. Panoramic View of Mt. Hilong-hilong, RTR, Agusan del Norte.

Fig. 5. Habitat Assesssment in one of the
sampling points on Canticol.

**Some Philippine-endemic and Mindanao-endemic Birds on Canticol and Mt. Hilong-hilong, Philippines**

Fig. 6. *Macronous striaticeps* (Philippine-endemic)
**Brown-tit Babbler**

Fig.7. *Aethopyga boltoni* (Near-threatened Mindanao-endemic)
**Apo Sunbird**

Fig. 8. *Rhipidura nigrocinnamomea* (Philippine-endemic)
**Black and Cinnamon Fantail**

Fig. 9. *Rhabdornis inornatus* (Philippine-endemic)
**Stripe-breasted Rhabdornis**

Fig. 10. *Centropus viridis* (Philippine-endemic)
**Philippine Coucal**

Fig. 11. *Harpactes ardens* (Philippine-endemic)
**Philippine trogon**

Fig. 12. *Parus elegans* (Philippine-endemic)
**Elegant Tit**

Fig. 13. *Sarcops calvus* (Philippine-endemic)
**Coleto**