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**MINALUNGAO NATIONAL PARK, NUEVA ECIJA, PHILIPPINES  
HOSTS SIX CHIROPTERA SPECIES**

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**ABSTRACT**

Order Chiroptera is the most diverse mammalian order in the Philippines. However, the Chiropterans are also likely the most poorly identified mammals in the Philippines. Species of Chiroptera were collected from three (3) caves at Minalungao National Park, a 2000-hectare protected area located at General Tinio, Nueva Ecija in Central Luzon, Philippines, which has not yet been identified for research, hence, limited existing published scientific studies. This is the first report of Chiropterans on Minalungao National Park, Philippines based on morphological characters, an update on the previously reported species based on a molecular marker, the mitochondrial cytochrome oxidase I (mtCOI). One endemic species is reported.

The study revealed a high diversity of chiropteran species at Minalungao. A total of 6 species of Chiroptera representing 2 suborders (Megachiroptera and Microchiroptera) and 5 families (Vespertilionidae, Hipposideridae, Emballonuridae, Pteropodidae, and Rhinolophidae) were identified using morphological characterization. These are: *Miniopterus australis* (Kulilit), *Hipposideros pygmaeus* (Tengang Baboy), *Taphozous melanopogon* (Ngusong Kabayo), *Rhinolophus arcuatus* (Panget), *Ptenochirus jagori* (Bangaag) and *Rousettus amplexicaudus* (Bayakan).

**Keywords: Chiroptera; Minalungao National Park**

## INTRODUCTION

Although known for its small land area, the Philippine archipelago is notable for the huge number of native endemic mammalian species and has the highest concentration of endemic mammals in a global scale with around 180 recorded mammal species; 110 of which are endemic [1, 2, 3, 4, 5, 6, 7].

Chiroptera species frequently fill up a high percentage of the diversity of all the mammals around the world [8]. Chiroptera is regarded as the most diverse order of mammals in the Philippines, with 25 megachiropteran and 48 microchiropteran described species [6,8]. Roughly 40% of these species are endemic [8]. However, the Chiropterans are also accounted probably as the least identified order of mammals in the Philippines [1,9]. In fact, only 70 species of Chiroptera were reported from the Philippines when the latest checklist was prepared in 1992 [3, 9].

Chiroptera plays a very substantial role in the biosphere as part of the density and complexity of ecosystems and food webs therein. As part of biodiversity, it consumes fruits of trees as their nutrition and provides food, as well, to consumers such as humans. Protection of forest habitats must be prioritized worldwide for the safety of Chiropterans [1,10]. The dire

need for conservation movements is caused by the devastation and damage of tropical forests and other anthropogenic threats such as hunting [1, 11].

Forest habitats have been acknowledged as principally essential for Chiroptera and a priority for conservation efforts globally [10] and the Philippines epitomizes an outstanding, if dismal, case. The forfeiture of forest habitats related to prevalent biodiversity have been well reported [6, 11], although, this in combination with the comparatively high endemism and a rate of species discovery which is amongst the greatest in the world [3] likens to an urgent necessity for conservation action. Accounted now as a hotspot in terms of biodiversity loss, conservation strategies are now being instigated in many areas in the Philippines. Among these is the establishment of national parks to help protect and conserve biodiversity.

Minalungao National Park located at General Tinio, Nueva Ecija in Central Luzon, Philippines, is a 2000-hectare protected area which has not yet been the focus for research and scientific studies. Presently, it serves as an ecotourism destination under the local government unit exhibiting stunning rock formations, fascinating river, and enchanting flora. It boasts high diversity of organisms that are con-

densed on species-rich forests and rivers and is also considered as one of the last natural environments north of Manila. It is an ecologically and biologically significant area where populations of globally threatened or geographically restricted species and undiscovered endemic species are expected to be found. It is a very good area for research particularly in studies for systematics, biodiversity conservation, microbiology, ecology, animal and plant physiology and biotechnology. These studies would be useful in the identification of plants and animal species that dwell in the area, as well as in determining the relationships and its ecological interactions.

While new species of Chiropterans have recently been reported, it is guessed that there are numerous species that may now be endangered and maybe extinct are still unknown [1, 9]. Since it has been confirmed that the assessment of the number of species of Chiroptera in Philippines that are extinct or endangered is not conceivable, faunal surveys are recommended in practically all parts of the country [12]. Around 50% of the megachiropteran fauna in the Philippines is vastly threatened as an outcome of extensive deforestation and hunting [8, 10, 13]. On the other hand, the status of Microchiropteran fauna is poorly known [1,2] although several of endemic species were already recognized.

Currently, an initial listing of chiropteran species at Minalungao National Park based on molecular identification using the mitochondrial gene marker cytochrome oxidase 1 (CO1) was reported [14]. This is a first report on the chiropterans of based on morphological identification. With this study, it provides information on establishing its biodiversity that may be used to employ conservation strategies and eventually for the protection of Chiroptera at Minalungao National Park.

## **MATERIALS AND METHODS**

### **Collection of Samples**

The different species of Chiroptera were collected from three (3) caves at Minalungao National Park such as Maipit Cave, Minalungao Cave and Makatulang Cave. Exact location was determined using the Global Positioning System (GPS). Consequently, abiotic factors such as air temperature and humidity were determined using thermo-anemometer and sling psychrometer respectively. The guidelines on handling wild animals for research were strictly followed.

### **Morphological Identification of Chiroptera**

The following morphological characters were used in identifying the collected Chiroptera based on [9]: (1) Total length; (2) Body length; (3) Ear; (4) Tail; (5) Hindfoot; (6) Forearm.

## RESULTS AND DISCUSSION

A total of 6 species of Chiroptera representing 2 suborders (Megachiroptera and Microchiroptera) and 5 families (Vespertilionidae, Hipposideridae, Emballonuridae, Pteropodidae, and Rhinolophidae) were identified. Eight phenotypes with different local names were initially separated. However, through morphological external measurements, 3 of those phenotypes were classified under one species, *Taphozous melanopogon* Temminck, 1841 (Black-bearded tomb bat) with local names of Ngusong kabayo (brown), Ngusong kabayo (black). Other species identified with common and local names were *Miniopterus australis* Tommes, 1848 (Little Bent-Winged Bat/ Kulilit), *Hipposideros pygmaeus* Waterhouse, 1843 (Philippine pygmy roundleaf bat/ Ngusong Baboy), *Rhinolophus arcuatus* Peters, 1871 (Arcuate horseshoe bat/ no known local name), *Ptenochirus jagori* Peters, 1861 (Greater musky fruit bat/Bangaag) and *Rousettus amplexicaudus* E. Geoffroy, 1810 (Common rousette/ Bayakan).

**Family Vespertilionidae**  
***Miniopterus australis* Tommes, 1848**  
**(Little Bent-Winged Bat/Kulilit)**

It has a total length of 87 mm; tail of 11.3 mm; hind foot of 6.2 mm; ear of 13.4 mm; forearm of 63.7 mm. Similar to all *Miniopterus*, this species has very dark

brown fur longer over the shoulders and top of the head than elsewhere on the body. Its tragus is small and is rounded and widest at the tip. The tip of its longest digit on the wing folds back rather firmly against the adjacent part of the wing, hence the English common name [15].

It nestles about 1000 m above sea level in agricultural areas, subsequent development, and principal forest, rarely comprising montane forest. It is frequently the most copious species in caves in distracted territories, with assessments habitually in the thousands. It often perches with *Miniopterus schreibersii* [4, 16, 17, 18, 19, 20]. The echolocation call of this species from Laguna Province was defined [21]. They are geographically prevalent and common but reliant on caves [15].

**Family Hipposideridae**  
***Hipposideros pygmaeus* Waterhouse,**  
**1843 (Philippine pygmy roundleaf bat/**  
**Ngusong Baboy)**

It has total length of 64.5 mm, tail of 39.4 mm, hind foot of 2 mm, ear of 5.8 mm, and forearm of 35.2 mm. The tiniest species of *Hipposideros* is in the Philippines. The dorsal pelage has two colors, white or cream at the base and dark brown at the tips. The ventral pelage is medium brown, darkest at the base. There are two sets of leaflets lateral to the anterior nose-leaf, the interior pair of which meet over-

head the mouth (at the foot of the noseleaf) to form a incessant leaflet[22].

This species is not well characterized and identified. This species has been caught in caves close to lowland forest, secondary lowland forest, from sea level to at least 200 m, over eroded limestone and soils[19, 20]. It is common but may be harmfully obstructed by the ruining of cave habitats. Lately there are increased captures, hence increased information. However, further field studies are critically required [22].

**Family** **Emballonuridae**  
***Taphozous melanopogon* Temminck, 1841 (Black-bearded tomb bat/Ngusong kabayo)**

It has a total length of 89 mm, tail of 29.3 mm, hind foot of 19.3 mm, ear of 14.5 mm, and forearm of 63.5 mm. It has a light brown fur with huge eyes, mild nasal area, and a low rounded tragus. It has a tail that is covered inside the tail membrane for the basal half but penetrates the membrane and lies on topmost of the membrane for the posterior half. Mature males have a spot of dark brown hair beneath the jowl [23].

It is widespread in urban regions, in areas with limestone caves, and in sea caves, at elevations at or below 150 m. It often settles in narrow areas of caves and in churches, libraries, and other construc-

tions with huge attics, effortlessly evident in hazy daylight [18, 19, 20, 24]. It is prevalent in Asia and plentiful in the Philippines [23].

***Rousettus amplexicaudatus* E. Geoffroy, 1810 (Common rousette/Bayakan)**

It has a total length of 100 mm, tail of 13.6 mm, ear of 13 mm, forearm of 63.7 mm, and hindfoot of 6.2 mm. It is a huge fruit bat, but males are significantly bigger than females. Back fur is dark brown or grey, frequently having an ice-covered look, and is somewhat little and thin. The muzzle is elongated and jagged, and the ears are moderately long. The wing membranes are dark brown but almost translucent over the bones, which give the look of white stripes. It has a claw on the primary edge of the wing. It is passive when held and seldom bites[25].

It is common in rural and housing areas up to 500 m and rare in agricultural areas from 500 to 1600 m. Furthermore, it is rarely in forest. All known nesting sites are in caves. Mature males are fewer than mature females. The species settles in huge groups (up to 100,000 per cave) and may have a harem type of reproducing system. They fly up to 25 km per night to forage. They naturally consume overripened fruit, producing less impairment in orchards than is usually thought of [12, 16, 17, 18, 26, 27, 28a 28b, 29]. It is prevalent

in Indo-Australia. It is locally abundant, normally firm, but exposed to extreme hunting at some cave habitats [30].

***Ptenochirus jagori* Peters, 1861 (Greater musky fruit bat/Bangaag)**

It has a total length of 117.6 mm, tail of 16.9 mm, ear of 14.6 mm, forearm of 87.6 mm, and hindfoot of 12.1 mm. It is an objectively huge fruit bat with a wide-ranging, black head and stouty snout. Orally, four upper and two lower incisors are present. Adults have a shoulder ruff of fur, typically with a gland below the ruff that secretes a yellow greasy substance, which marks the ruff. A smell of cinnamon is a common distinguishing characteristic, especially on males. Males are somewhat bigger and darker than females [31].

It is plentiful in primary forest, widespread in secondary forest, frequently seen in farmland and urban parks and domestic areas. It is seen from sea level to at least 1950 m. Frequently, it is one of the most populous bats in lowland forest, with densities of 1 to over 3 per hectare. Mature males have full length about half the size of those of mature females. It consumes greatly on figs and other fruits such as banana (*Musa* spp.). Perching spots have been discovered in hollow trees and in narrow caves in limestone and clay panels. Genomic records infer equally high levels of gene flow throughout the Philippines [9,

12, 17, 20, 26, 27, 28a, 28b, 32, 33, 34]. Its population is big and commonly constant, extensive, and forbearing of seriously bothered habitat [31].

**Family Rhinolophidae**  
***Rhinolophus arcuatus* Peters, 1871 (Arcuate horseshoe bat; no known local name)**

It is a medium to small *Rhinolophus*, with total length of 61 mm, hind foot of 19.6 mm, ear of 39.2 mm, and forearm of 56.4 mm. The fur is generally moderate brown posteriorly, and somewhat lighter anteriorly. The noseleaf is almost as broad as the muzzle, and there are no additional leaflets [35].

It can be seen from sea level to 1950 m, in farmlands, second growth, and primary forest, frequently abundant in the lowlands but rarely in montane and mossy forest. Perching spots are in caves, fissures, rocky ledges, and in deep trees. It is more effortlessly caught in harp ploys than in haze nets [4, 16, 17, 18, 19, 21, 28a, 28b, 36, 37, 38]. The echolocation calls of specimens from Laguna Province, Luzon were defined [21]. They are prevalent and locally common [35].

A total of 6 chiropterans were identified at Minalungao National Park, Philippines using morphological characters. This embodies nearly 9% of the Philippine bat community out of the 68 species re-

ported [39]. The Philippine bat fauna unveils remarkably great rate of endemism, definitely among the utmost in the world [40]. In fact, one species reported in this study, *Ptenochirus jadori*, is endemic to the Philippines [41]. This great level of bat diversity and endemism may be caused by optimum environmental conditions of the region. Chiroptera predominantly occupies jungles and rich areas such as rivers that give an essential territory for bat fauna by giving uninterrupted treasured resources. Riparian habitats, shown by the Minalungao area that comprises rivers, are significant habitats for many species of Chiroptera because it provides food and water. Bat searching activity ensues prominently in this type of habitat [42]. Moreover, high diversity of the chiropterans maybe caused by the occurrence of trees and insects in the area that chiefly constitutes their diet.

Furthermore, this diversity of bats in the area shows the quality of the environment. With its environmental significance on diverse habitats, Chiroptera is a good indicator of integrity of natural communities because of its number of resource qualities such as nestling, irrigating, and nourishing habitats presenting rapid population variations if supply attribute is misplaced [43]. The significance of recording the existing species in the area is signified. Because of the frugi-

vorous diet of some of the species of Chiroptera, they are likewise referred to as several of the most essential seed dispersors, crucial for the redevelopment of the forests and establishment of the fresh spaces by plants [44]. The occurrence of the bat species in the caves they were collected gives us an idea of the diet of the chiropterans and the species of plants and animals surrounding the location.

Since only morphological measurements were employed in the identification, more molecular studies on these species, aside from the initial molecular barcoding studies done [14], are now underway to accurately verify species assignment as 8 initial phenotypes were characterized with three different phenotypes were classified only under one species, *T. melanopogon*. Morphological identification may be unreliable and can be challenging and it is not always conceivable to classify bats only by outward characters [45] as specific species may be very comparable in form, hence species assignment as well as phylogeny can only be fixed using up-to-date molecular methods [45]. Through succeeding researches, it is hoped that this opens up the idea of discovering more endemic and unrecorded chiropterans in the Philippines, particularly at Minalungao National Park as well as design-

ing strategies for its conservation and management.

## CONCLUSION

A total of 6 species of Chiroptera representing 2 suborders (Megachiroptera and Microchiroptera) and 5 families (Vespertilionidae, Hipposideridae, Emballonuridae, Pteropodidae, and Rhinolophidae) were identified using morphological characters. These are: *Miniopterus australis* (Kulilit), *Hipposideros pygmaeus* (Tenggang Baboy), *Taphozous melanopogon* (Ngusong Kabayo), *Rhinolophus arcuatus* (Panget), *Ptenochirus jagori* (Bangaag) and *Rousettus amplexicaudus* (Bayakan). One endemic species is reported.

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