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A Preliminary Assessment of the Chiropteran Fauna of the Oro River, Cagayan de Oro City, Philippines

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Abstract - Bats are integral components of the environment serving an indispensable role in maintaining the health of different ecosystem ranging from forested areas up to riparian zones. Rivers and riparian areas provide an important habitat for bat fauna by providing direct valuable resources. The bat fauna along the Cagayan de Oro river had never been assessed and the current study was the first. Bat survey was conducted in different relevant locations along the river communities through mist netting designed to provide baseline ecological information and initial data on species composition and

biometrics of bat species present in the Cagayan river zone. Eight bat species – five Pteropodids, two Vespertilionids and one Emballonurid – were recorded representing 15% of the bats of Mindanao faunal region and over 10% of the total Philippine bat fauna. Two species were Philippine endemics though with stable population status but are considered of conservation priority. Further studies along more complete portions of Cagayan de Oro river would likely add essential information on bat species composition and distribution in the area and would give a clearer overview regarding the bat fauna along the Cagayan de Oro river.

Keywords - Chiroptera, bat diversity, Philippine bat fauna, Cagayan de Oro river, Riparian, Cagayan de Oro City, Philippines

INTRODUCTION

The Order Chiroptera is an important component of biodiversity comprising one third of all mammalian species in mainland Southeast Asia (Francis, 2008). Among mammals, bats (Chiroptera) are regarded as one of the most vulnerable taxa in which among the approximate 1,001 known species of bats, nearly 25% of which are globally threatened (Mickleburgh et al., 2002). In the Philippines, Chiroptera is the most diverse order of mammals with 78 known bat species belonging to six families (Heaney et al., 2010). The order Chiroptera is divided into two suborders, the Megachiroptera with a single family Pteropodidae and the Microchiroptera with four families (Ingle and Heaney, 1992).

In Mindanao region, there are a total of 53 known bat species present fewer than five bat families of which three species are known to be distributed only in the Mindanao Islands including *Alionycteris paucidentata* and *Ptenochirus minor* both under the Family Pteropodidae and *Hipposideros coronatus* of the Family Rhinolophidae (Ingle et al., 1999). Considerably, the Philippine bat fauna has exceptionally high value of endemism, undoubtedly among highest in the world (Heaney et al., 2010).

Bats inhabit varied sets of habitats ranging from forest, agricultural area, urban and riparian habitat (Kunz and Fenton, 2003). Riparian habitats including rivers are important habitat for several bat species

by providing food, water and is widely accepted that bat foraging activity is commonly greatest in these areas (Racey, 1998). With its ecological importance on different habitats, bats have been proposed as good indicators of the integrity of natural communities because they integrate a number of resource attributes (roosting, watering, and feeding habitats), and thus may show population changes quickly if a resource attribute is missing (Hutson et al., 2001).

Despite of the diverseness of chiropteran fauna in the Philippines, knowledge on the ecology and taxonomy of Philippine bat fauna was fragmentary mostly focusing on reserve areas (i.e Duya et al., 2006; Heaney et al., 2006, 2011). In Cagayan de Oro, data on bat faunal composition is scarce and assessment is highly in need. This paper presents the results of the survey designed to assess the chiropteran fauna of Cagayan de Oro river. The current research primarily aims to survey the chiropteran fauna within the habitats along the Cagayan river and assess bat species richness and abundance and ascertain future conservation needs. There is currently no published information regarding bat assemblages in this area and this would serve as a good baseline research for the assessment of bat species present along the Cagayan de Oro river by providing initial data of chiropteran assemblages.

OBJECTIVES OF THE STUDY

This research primarily aims to assess the bat species richness and determine the basic morphometrics, relative abundance and conservation status of each bat species and provide relevant baseline data on bat faunal composition within the habitats along the Cagayan river.

MATERIALS AND METHODS

Sampling Locations

Our sampling survey of bats in Cagayan de Oro river was conducted primarily along the riparian habitats located within one kilometre of the river ranging from mixed secondary and agricultural

habitats to mangrove habitat in four sampling stations.

Station 1 (08°17'427 N; 124°35'124 E, elevation: 4.9 masl) - Upstream of Brgy. Dansolihon. This station was considered to be moderately disturbed habitat characterized as a mixed species forest with a reduced density of large pioneering forest trees. Fruiting trees noted includes fig species - *Ficus nota* and *Ficus septica*, Mansanitas (*Muntingia spp),* Starfruit *(Averrhoa spp),* Tambis *(Syzygium spp)* and Coffee *(Coffea arabica)*. Large trees noted include *Ceiba pentandra, Chrysophyllum cainito,* and *Terminalia catappa.* Bamboos (*Bambosa spp.)* were also common. Some areas were densely covered with climbing bamboos (*Schyzostachium spp*). Ground vegetation was mostly carabao grass and ground ferns. A fragmented area with banana (Musa *spp*) plantation was also noted along the area.

Station 2 (08°23'324N; 124°36'774 E, elevation: 3.7 masl) – Brgy. Lumbia near the Kabula Bridge. The vegetation within this site were mostly non fruiting trees such as *Leucaena leucocephala, Gmelina arborea and Paraserianthis falcataria* which are introduced species. Trees along the river side were densely covered with climbing bamboos. A papaya (*Carica papaya*) plantation was also present nearby the area.

Station 3 (08°23'317N; 124°37'776 E, elevation: 2.74 masl) – Barangay Buena Oro near the Pelaez Bridge. This sampling location was mostly dominated by coconut trees (*Cocos nucifera*) and agricultural crop such as Banana (*Musa spp*). Fruiting trees includes Figs (*Ficus spp*), Mango (*Mangifera indica),* Mansanitas *(Muntingia spp)* and *Guava (Psidium guajava).* Ferns and grasses (*Paspalum conjugatum*) mostly constitutes the ground cover.

Station 4 (08°29'862N; 124°38'983 E, elevation: 2.74 masl) – Barangay Puntod near Puntod Bridge. This site was considered as an estuarine habitat with the domination of mangrove vegetation. Coconut was also dominant making most of the vegetation cover. Ground vegetation were mostly covered with weeds, amorsiko and grasses (*Imperata cylindica, Saccharum Spontaneum)*. Fruiting trees present includes Figs (*Ficus spp*), Mansanitas (*Muntingia spp*) and Banana (*Musa spp*).

Bat Sampling

Bats were captured through mist netting using a standard 2.5 by 12 meters mist nets with 36 mm mesh size. Nets were set across likely flight paths in the area including a break in vegetation, along fruiting trees, trails and along the riparian zone. Mist nets were opened at dusk and were checked at least every half hour until 2200 H and were left open until dawn.

The sex, age, reproductive condition of captured bats was recorded and standard external measurements (total length, tail length, forearm length and ear length) were taken to aid identification. Captured bats were marked with a nail polish on its hindfoot to avoid recounting. Any recaptured bats were immediately released and were not included in the results. Nomenclature follows the taxonomic guide of Ingle and Heaney (1992).

For each netting night, the geographic location, weather conditions and time the nets were operational was noted.

RESULTS AND DISCUSSION

A total of eight bat species under two suborder and three families were captured representing almost 10% of the Philippine bat community (Heaney et al., 2010) and 15% of the total bats found in Mindanao Island (Ingle et al., 1999). Five species were under the Family Pteropodidae including *Cynopterus brachyotis*, *Macroglossus minimus, Ptenochirus jagori, Ptenochirus minor* and *Rousettus amplexicaudatus*, two species under Vespertilionidae including *Scotophilus kuhlii* and *Myotis horsfieldii* and single species under Family Emballonuridae, *Taphozous melanopogon*. The presence of two endemic bat species namely *P. jagori* and *P. minor* with the latter specifically endemic to Mindanao faunal region was significant since this species are considered conservation priority (Table 1).

Among the species captured, *C. brachyotis* was the most abundant with an abundance of 21 caught individuals accounting for 38% of the captures followed by *Rousettus amplexicaudatus* comprising 24% of the total bat captured. Of the eight bat species, three were insectivores including *M. Horsfieldii, T. melanopogon* and *S. Kuhlii* , one

nectarivore namely *M. minimus* and the rest are frugivores comprising large proportion of most captures. For all adult individuals, external morphological data was recorded for each bat species (Table 2).

Table 1. Bat species captured in four sampling locations along the Cagayan Rivers. Total bat captures are given for each species along with the standardized abundance given in parenthesis. Asterisks mark species observed but not captured

Family	Species	Station 1	Station 2	Station 3	Station 4
Pteropodidae[1]	*Cynopterus brachyotis*	6 (3)	5 (2.5)	4 (2)	6 (3)
	Macroglossus minimus	4 (2)	0	0	5
	Ptenochirus jagori [3]	3 (1.5)	0	2 (1)	3 (1.5)
	Ptenochirus minor [3]	2 (1)	0	0	0
	Rousettus amplexicaudatus	1 (0.5)	5 (2.5)	4 (2)	3 (1.5)
Vespertillionidae[2]	*Myotis horsfieldii*	0	0*	0	0
	Scotophilus kuhlii	0	2 (1)	0	0*
Emballonuridae[2]	*Taphozous melanopogon*	0	0*	0	0
Total Captures		16	12	10	17
Total Species		5	3 (+2)*	3	4(+ 1)*
Total Net Nights		2	2	2	2
Bats per net night		8	6	5	8.5

[1] Megachiroptera
[2] Microchiroptera
[3] Philippine Endemics

Table 2. Means (± SD) and Ranges of selected external measurements of Adult bat species netted in Cagayan de Oro river. All measurements are in millimetre. Measurements taken from sample size of 2 are given as average and their ranges.

Species	Sex	No. of Individuals	Morphometric measurements (mm)			
			Forearm length	Ear length	Tail length	Hindfoot lenght
Cynopterus brachyotis	Male	9	62 - 68	14 - 18	5 - 12	12 - 16
			64.6 ± 1.88	15.75 ± 1.58	8 ± 2.78	14.11 ±1.76
	Female	7	64 - 66	14 – 20	4 – 10	14 – 16
			65 ± 0.82	17.6 ± 2.29	6.4 ± 1.88	14.85 ± 0.90
Macroglossus minimus	Male	3	42 - 45	12 - 16	0	12 - 14
			43.7 ± 1.53	14 ± 2.0	0	13.3 ± 1.15
	Female	6	42 - 45	12 - 16	0	12 - 14
			44 ± 1.22	14.16 ± 1.60	0	12.83 ± 0.98
Ptenochirus jagori	Male	5	80 -88	18 -24	12 - 16	17 - 22
			84.8 ± 2.95	21.2 ± 2.28	14.6 ± 1.67	19.4 ±1.94
	Female	3	82 - 88	18 -22	12 - 16	16 - 21
			85 ± 3.0	12.7 ± 1.53	14.7 ± 1.54	18.3 ± 2.52
Ptenochirus minor	Female	2	73 -75	19 - 21	13 - 14	17 - 19
			74.5	20	13.5	18
Rousettus amplexicaudatus	Male	8	80 - 90	18 - 22	15 - 21	18 - 22
			85.37 ± 3.16	20.12 ± 1.55	18.25 ± 2.05	19.87 ± 1.55
	Female	5	82 - 90	19 - 22	16 -20	19 -22
			85.6 ± 2.97	20.8 ± 1.30	19.6 ± 1.67	20.4 ± 1.14
Scotophilus kuhlii	Male	2	50 - 52	12	47 - 48	8 - 10
			51	12	47.5	9

Accounts of Species (Fig. 1):

Cynopterus brachyotis (Müller, 1838) - The common short nosed fruit bat is widespread in South East Asia and common in Philippines which is typically found in agricultural and urbanized areas and also common in secondary lowland forest in which this species can be found varied habitats ranging from orchards, vegetations along waterways and forest tracts (Heaney et al., 1998). In Cagayan de Oro river, *C. brachyotis* was abundant in all sampling locations being netted frequently. A total of 11 male *C. brachyotis* were captured of which nine were adults and two were juveniles. There were three juvenile females caught and seven adults in which two were lactating and one pregnant.

Macroglossus minimus (É. Geoffroy, 1810) -The dagger-toothed flower fruit bat occurs throughout the country. It is common in every habitat in the Philippines and often abundant in agricultural habitat and heavily disturbed areas, also common in secondary forest and usually uncommon in primary forest (Heaney et al., 2006). *M. minimus* was captured in both stations 1 and 4 where flowering trees are mostly abundant. This species is considered to be strongly associated with domestic and wild banana (*Musa spp*; Heaney et al., 1998) which was quite abundant in the first sampling location. Our limited netting captured four individuals in station one and six individuals in station 4. All captured individuals were adults of which three were males and six females.

Ptenochirus jagori (Peters, 1861) -The greater musky fruit bat is a Philippine endemic being found in secondary forest and is common in lowland agricultural areas (Heaney et al., 2006). *P. jagori* was captured in all sampling locations except at station two. A total of eight individuals were netted comprising of seven adults and one juvenile. Three adult females were caught with an enlarge mammae but not lactating

Ptenochirus minor Yoshiyuki, 1979 - The lesser musky fruit bat is endemic to the mindanao faunal region which was found to be abundant in primary forest but also common in old growth and disturbed lowland forest (Heaney et al., 2006). This species was exclusively captured in Station one with two netted individuals. All caught individuals were all adult nonpregnat females.

Rousettus amplexicaudatus (É. Geoffroy, 1810) - The common rousette fruit bat has widespread distribution ranging from Thailand and found throughout the Philippine archipelago (Heaney et al., 2006). *R. amplexicaudatus* was the second most netted species after *C. brachyotis* with 13 caught individuals, eight of which are adult males and five adult females.

Myotis horsfieldii (Temminck, 1840) - In Philippines, the common asiatic myotis was recorded in secondary and old-growth lowland, montane, and mossy forest and in agricultural areas often forages just above the water surface along streams, and is usually absent where streams are lacking and usually roosts in caves and in tunnels, and reported roosting beneath a large rock over a stream (Sedlock et al., 2008). This species was observed gleaning above water source in station 2 where abundant insect concentrations fly along the river zone.

Scotophilus kuhlii Leach, 1821 – The Lesser Asian House Bat usually forage in anthropogenic and agricultural areas and common on lowland secondary forest as well. This species commonly roost in buildings and sometimes forms tents from modified palm fronds (Heaney et al., 2010). Two adult individuals of *S. kuhlli* were netted in station 2 and a number of this species were observed at station 4 flying above sky at around 1730 h.

Taphozous melanopogon Temminck 1841 – The Black – bearded tomb bat is widespread in Asia and abundant in the Philippines often found in hilly forest country near water but they may roost in many places including tombs, caverns, caves, rock crevices, sea cliffs, and trees (Heaney et al., 2010). Philippine populations were formerly separated as *T. philippinensis*, but these are now considered to be a subspecies of the widespread species (Simmons, 2005). This species was observed flying at high elevation in station 2 before dusk.

Fig. 1. Bat species netted along the Cagayan de Oro river.
A. *Cynopterus brachyotis*; **B**. *Macroglossus minimus*; **C**. *Ptenochirus jagori;* **D**. *Ptenochirus minor;* **E.** *Rousettus amplexicaudatus* and **F.** *Scotophilus kuhlii*

Eight of the 78 known bat species in the Philippines (Heaney et al., 2010) have been recorded, representing over 10% of the Philippine bat fauna. Within the Mindanao island, it constitutes to about 15% out of 53 bat species known to occur in Mindanao faunal region (Ingle et al., 1999). The majority of the recordings were consists of fruit bats, in particular, the Common short-nosed fruit bat (*C. brachyotis*) and the common rousette fruit bat (*R. amplexicaudatus*). Bat species with conservation importance includes the Philippine endemic *P. jagori* and Mindanao endemic *P. minor* of which the latter had a low capture rate. Though this endemic species were categorized as least concern or with stable population trend (IUCN, 2012), it has been considered that endemics are under constant threat as a result of habitat conversion and changes (Heaney and Regalado, 1998).

Bat fauna on Cagayan de Oro river were mostly dominated by generalist species such as *C. brachyotis*, *M. Minimus* and *S. kuhlii*

whose distribution is widespread and very tolerant to habitat changes (Heaney et al., 2006). It is noteworthy that the habitat along Oro river had been homogenized generally with the abundance of non native plant species such as *Gmelina arborea* and others (see Methodology). Such changes in vegetation cover could be the result of the calamity during the Storm Sindong or perhaps due to constant land conversion for agricultural usage along the area of Cagayan de Oro river. It has been recognized that modifications in composition of vegetative communities and alterations in water quality along riparian corridors may be foreseen to affect chiropteran composition and foraging behavior of bats (Williams et al., 2006) in which such changes provide suitable habitat and benefits only to those highly adaptable and generalist bat species by providing new resources (Fenton, 1997).

Cynopterus brachyotis constituted most of the significant captures. This species is highly adapted to their environments to take advantage of many available shelters such as caves, trees, rock shelters and occupies a variety of habitats including primary rainforest, disturbed forest, mangrove swamp, cultivated area, orchards, gardens and urban areas (Tan et al., 1999). The presence of *C. brachyotis* in Cagayan de oro river could possibly represent an endemic sub-species as proposed by Schmitt et al. (1995) considering the populations of *C. brachyotis* in the Philippines to represent a separate species *C. luzoniensis*, however further study is valuable.

The presence of *R. amplexicaudatus* in all sampling locations along the Cagayan river could be accounted with the presence of caves in the area or maybe due to the availability and abundance of fruiting trees such as Figs (*Ficus spp*.) which serve as food for this species. Hence, the ability of bats to move long distances with relatively low energetic cost gives them access to a variety of habitats and decreases their dependence on any one particular area (Fenton, 1997) making *R. amplexicaudatus* of widespread distribution.

The low captures of insectivore bat species were maybe accounted to the capturing technique being employed. It was known that insectivores navigate through sonar system and emit high-frequency echolocation calls allowing them to detect the traps deployed ahead (Sedlock et al., 2001). Insectivorous species in the Philippines were usually underrepresented in most bat surveys (Sedlock et al., 2011) and is comparable with the result of this study with only a single

insectivore bat species being netted. More insectivorous bat species are inferred to be present in the area and extensive netting would be warranted to yield more complete assessment.

Since the netting effort was very limited, it does not imply that only eight bat species do occur in the area, extensive netting would give a clearer overview regarding the bat fauna along the Cagayan de Oro river. Our record of eight species constituted with four frugivores, three insectivores and one nectarivore species is worth noting since this species might provide various ecological services directly or indirectly in the Cagayan de Oro river. The rich diversity of dietary habits of bats, ranging from species that feed on insects and other arthropods to those that feed on fruit, nectar, and flowers provide valuable ecological services by serving as primary, secondary, and tertiary consumers that support and sustain both natural and human dominated ecosystems (Kunz and Fenton, 2003).

The seemingly high number of Pteropodid bat species – including the fruit eating *C. brachyotis, P. jagori, P. minor, R. amplexicaudatus* and the nectar feeding *M. minimus* - present in Cagayan de Oro river is compelling since frugivorous bats help maintain the diversity of forests by dispersing seeds across different ecosystems, often introducing novel plant species into previously disturbed landscapes (Kelm et al., 2008). Similarly, nectarivorous bats that visit flowers provide valued ecosystem services by pollinating plants, dispersing pollen, and, thus, helping to maintain genetic diversity of flowering plants (Fleming et al., 2009). Hence, bats along with many other flower visiting and fruit-eating animals provide important mobility for plant gametes and propagules (Kunz et al., 2011).

With respect to insectivorous species recorded along the Cagayan de Oro river, the three recorded species – *S. kuhlii, M. horsfieldii* and *T. melanopogon* is certainly insufficient number but is significant since this bats could probably considered as insect population regulators within the Cagayan river zone. Insectivorous species, largely feeding on airborne insects and other arthropods, suppress both naturally occurring and anthropogenically-generated insect populations (such as agricultural pest species and insects that annoy or transmit specific pathogens to humans and other mammals) and contribute to the maintenance of ecosystem stability (Kunz et al., 2011).

CONCLUSION

The current research provides initial findings regarding the chiropteran fauna along Cagayan de Oro river that might serve as good basis in pursuing future conservation measures. Cagayan de Oro river support a remarkable assemblage of bat fauna with emphasis on Philippine endemics. Further studies along more complete portions of Cagayan de Oro river and additional netting effort are needed to determine whether still more bat species are present especially the Philippine endemic species. Although the representatives of bats of Cagayan de Oro river are likely stable and not presently under extreme threat, it is significant to monitor the health of Cagayan river as well as the bat species present in the area to ensure the continued existence of these species. More bat research is recommended as a follow up of the current initial survey.

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