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Population estimate of the cave-dwelling bats *Miniopterus schreibersii* and *Rhinolophus subrufus* in Pader Cave, Barangay Victoria, Zamboanga City, Mindanao, Philippines

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ABSTRACT

Pader Cave in Barangay Victoria, Zamboanga City is a newly mapped cave registered in the roster of the Department of Environment and Natural Resources (DENR) of Region IX, Mindanao, Philippines. Caves such as these serve as a safe and stable environment for diverse life forms including bats; however, human encroachment continues to disturb this environment and may endanger many cave-dwelling species. Herein, identification and population estimate of cave-dwelling bats were conducted in Pader Cave, Zamboanga City as a basis to develop effective conservation prioritization to address biodiversity issues amidst increasing cave disturbances. Two (n=2spp.) species of insect bats were identified, namely *Miniopterus schreibersii* and *Rhinolophus subrufus*. Populate estimates reached 10, 682 individual insect bats through the standard quick population count method in roosting bats. Harp trap and scoop net were utilized in collecting a voucher specimen for identification purposes. With the observed human disturbances in Pader Cave (such as bat hunting and vandalism), immediate protection and conservation actions should be implemented to protect the bat population and cave environments.

Keywords: roosting, insect bats, population estimate, Pader Cave, Zamboanga City

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INTRODUCTION

Caves are considered to be a unique ecosystem that provides scientific, economic, educational, cultural, historical, and aesthetic values (Kunz *et al*., 2011). In some countries, caves can provide stable habitat to some threatened animals (Andres *et al*., 2009; Tanalgo *et al.*, 2018). Examples of these animals which thrive in caves are bats that belong to mammalian class, with at least seventy-eight (78) species known to be found in the Philippines (Tanalgo & Hughes, 2018). Out of this, there are at least twenty-five (25) species of fruit bats and fifty-three (53) species are insect bats (Tanalgo & Hughes, 2018). Moreover, there are twenty-two (22) species of bats that are endemic to the Philippines and thirty (30) species of bats are found roosting in caves (Gomez, 2010; Tanalgo & Hughes, 2019). A large percentage of the Philippine bats are dependent on either intact forests or caves (Ingle *et al.*, 2011; Tanalgo & Hughes, 2018; Tanalgo & Hughes, 2019).

Recognizing the role of caves in bat biodiversity, the Protected Areas and Wildlife Bureau of the Department of Environment and Natural Resources (PAWB-DENR) has recorded over 1, 500 caves found in the Philippines since the implementation of Cave Management and Conservation Program (CMCP) in 1994. According to Andres *et al.* (2009), with the integration of different methods and intensifying samples, there is still a significant number yet to be discovered and mapped. With the initiatives on cave mapping developed by DENR and other conservation scientists in the country, the identification of cave roosting bats has also intensified in recent years. Cave bats, particularly those insect-eating bats, have important ecological roles in controlling the insect-pest populations and therefore reducing the use of insecticide particularly in rice fields (Srilopan *et al*., 2018). Fruits bats, on the other hand, play a big role in pollination and seed dispersal (Kunz *et al*., 2011).

However, bat research in the Philippines remains to be unequally distributed across the country, especially in Southern regions of the Philippines (Tanalgo & Hughes, 2018; 2019). The Pader Cave located in Barangay Victoria, Zamboanga is one of the caves that is known to host a large population of cave-dwelling bats; yet clear scientific investigation was never been conducted before. Apart from this, anthropogenic activities such as vandalisms and bat hunting as a source of food continue to be a large threat to the cave, thus threatening its biota.

Therefore, in an aim to support the biodiversity management of the cave in the region, this study generally aimed to identify, and conduct population estimate of cave-dwelling bats at Pader Cave, Barangay Victoria, Zamboanga City. Ecological suitability of the cave was also assessed through geoclimatic parameters (temperature, humidity, light intensity) and human disturbance. It is hoped that the findings will serve as reference to developing local policies to protect the cave sites.

METHODS

Site and Location of the Study

Pader cave is located at Barangay Victoria, Zamboanga City at an elevation of 227 masl located between N 07°02.575’ and E 122°10.406’. Barangay Victoria is about 24 kilometers from the city hall of Zamboanga City and on the main east coast highway. The road is accessible to most of land transportation vehicles. Pader Cave is located near the river and is characterized by a wet and muddy ground from the guano of insect bats. It is surrounded by tall trees (*e.g.* Mahogany, Gmelina, Coconut, Marang, Bamboo, Palms and Ferns) (Fig. 1).

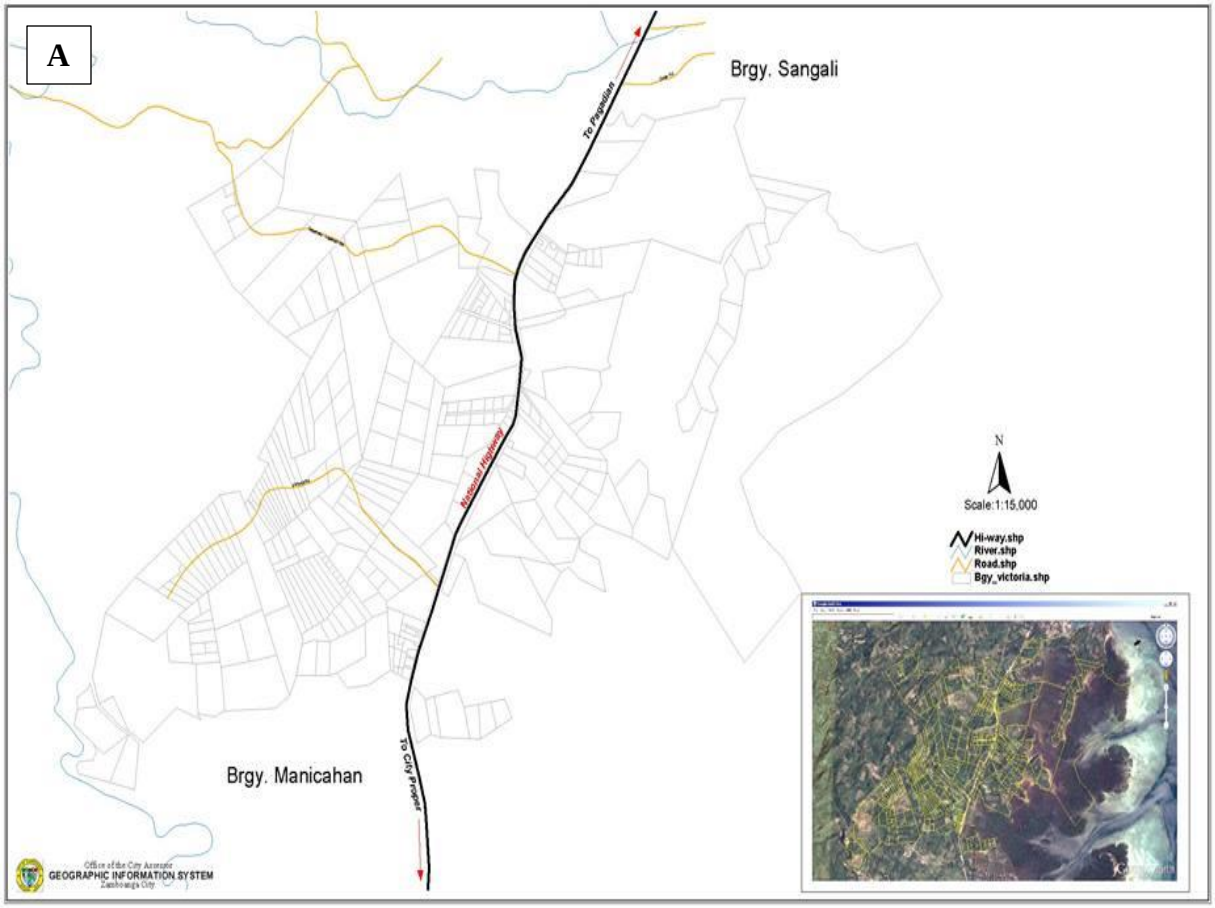

Figure 1. Map of Barangay Victoria, Zamboanga City (A) (Courtesy of Erwin E. Bernardo; Office of the City Assessors, Zamboanga City) and actual study site (B).

Cave Mapping

Cave mapping is a process by which a survey or mapping is conducted in cave archaeological research (Trimmis, 2018). This is also an initiative of the Department of Environment and Natural Resources to map all existing caves in the Philippines for conservation measures (Andres *et al*., 2009). Figure 2 shows the mapped Pader Cave with arrows to indicate the roosting bats.

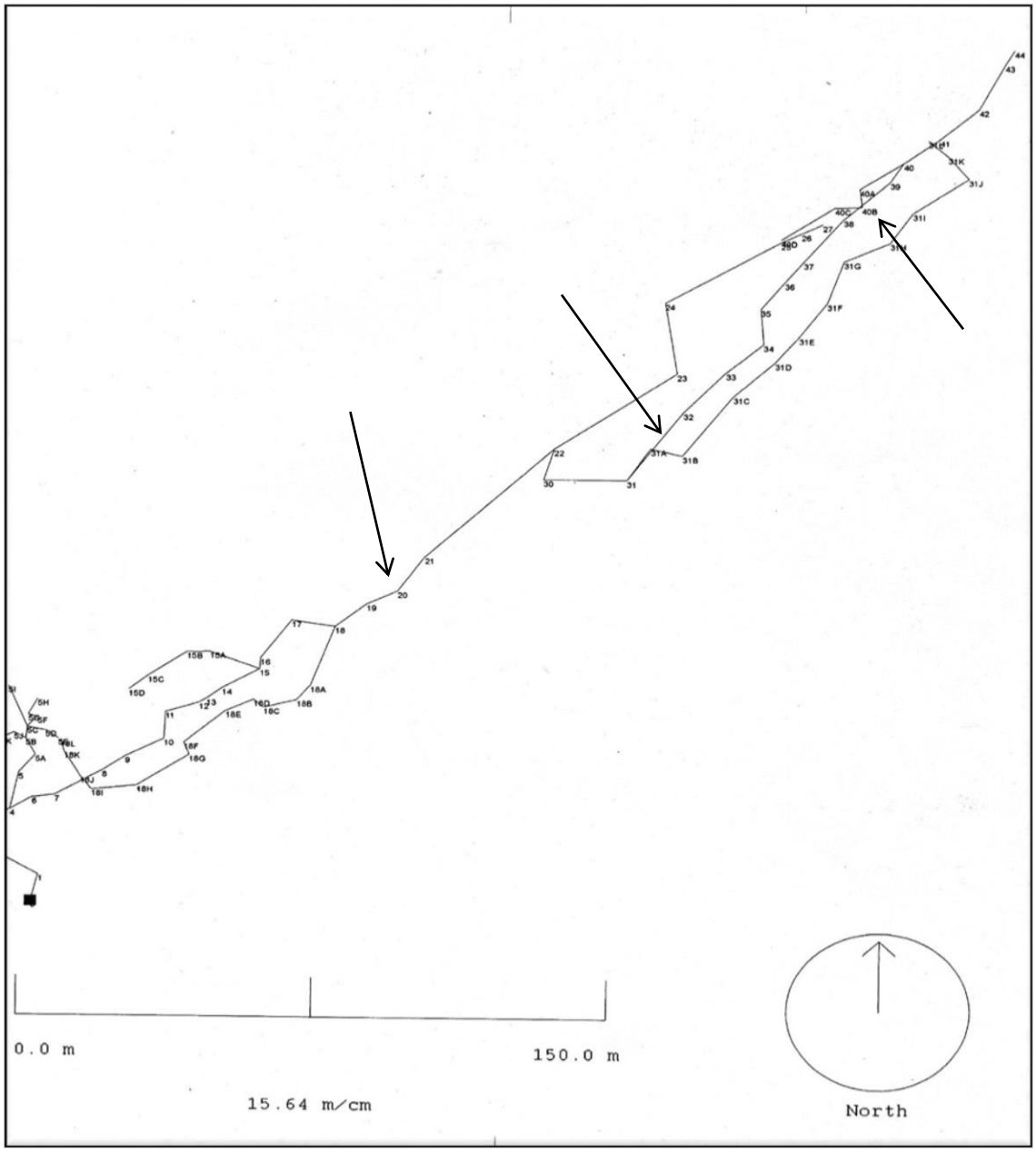

Figure 2. Pader Cave Map (Courtesy of Mr. Marc Mentens).

A cave map being mapped by Mr. Marc Mentens, President of the Zamboanga Peninsula Cavers Association and a member of the Regional Cave Committee (RCC) of the DENR, was

utilized by the researchers. Establishment of the sampling area was based on the area and chambers where cave-dwelling bats are seen indicated by the arrows.

Data Gathering Procedure

Harp trap and scoop net were used in collecting cave-dwelling bats. The harp trap was set near the opening of the cave where it did not require constant attention. However, it was checked hourly, because some lactating or pregnant bats have the probability to be caught. Captured bats were then placed in a cloth bag (Ingle *et al*., 2011).

Morphometric Measurements of the Samples

The definitions of standard external measurements being followed are illustrated in Figure 3.

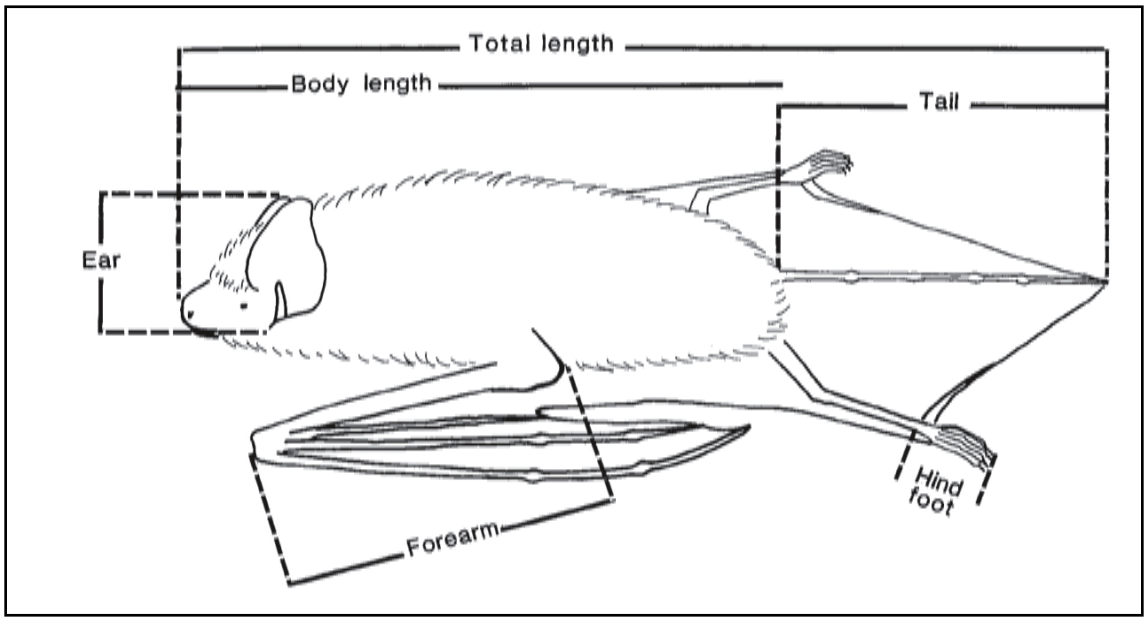

Figure 3. Morphometric features of the bat.

The following morphometric features was taken for identification purposes:

a. Forearm length	b. Hind foot length	c. Tail length
d. Ear length	e. Body length	f. Total length

The forearm length is measured from the base of the thumb to the end of the ulna. Hindfoot length is measured from the tip of the toe to the tibia. Body length is measured from the tip of the nose to the tip of the tail. Tail length is measured from the tip of the tail to the end of the tail (near the anus). Ear length is measured from the tip of the ear to the end of the ear. Total length is measured from the tip of the nose to the end of the tail.

Sex Identification of the Bats

Bats' sexes can be determined by examination of their external genitalia. Males have a conspicuous penis. Both male and female bats possess axillary nipples on the upper chest, usually near the armpit. However, the nipples of adult females are more prominent than those of males.

Identification and Classification

Samples were identified using Fieldiana: A Key to the Bats of the Philippine Islands (Ingle & Heaney, 1992). All external measurements were taken and keyed out applying the measurements on the key guide. Other features such as sex, age and reproductive condition were also recorded. If the measurements did not match, the identification was considered questionable and the process was repeated from the first step. Identification protocol was adapted from Ingle and Heaney (1992). Validation was done by an expert.

Population Estimate of Cave-dwelling Insect Bats

For the estimated population count, quick total count method was used since Pader Cave ceiling is too high (Sedlock & Ingle, 2010). The same procedure was also patterned from the works of Iran and Quin (2012).

Assessment of Physical Parameters and Ecological Suitability

For the assessment of the physical parameters, a thermal hydrometer was used to determine the temperature and humidity of the cave. A photometer was used to assess the light intensity inside the cave. Qualitative observations were made to determine ecological suitability in terms of evidence of human disturbance.

RESULTS AND DISCUSSION

Two (2) species of insect bats were recorded in Pader Cave, Barangay Victoria, Zamboanga City, namely: *Miniopterus schreibersii* and *Rhinolophus subrufus*. The first insect bat belongs to Family Vespertilionidae (or evening bats); while the second species belongs to Family Rhinolophidae (or horseshoe bats). There were no species of fruit bats found in the area. Table 1 shows the morphometric measurements of both male and female insect bats. These external morphometric measurements provide substantial aid in identification. Figure 4-5 shows the actual documented representative of each species.

Table 1. Morphological character measurements of cave-dwelling bats in Pader Cave, Barangay Victoria, Zamboanga City.

Species	Gender	Forearm Length (cm)	Body Length (cm)	Total Length (cm)	Tail Length (cm)	Ear Length (cm)	Hindfoot Length (cm)
Miniopterus schreibersii	Male	42.5	47	91.6	44.7	6.5	5.9
	Female	36.5	42.4	80.7	38.3	6.1	5.1
Rhinolophus subrufus	Male	40.4	40.9	56.8	15.4	19.1	5.7
	Female	36.8	41.8	63.9	22.2	20.1	5.6

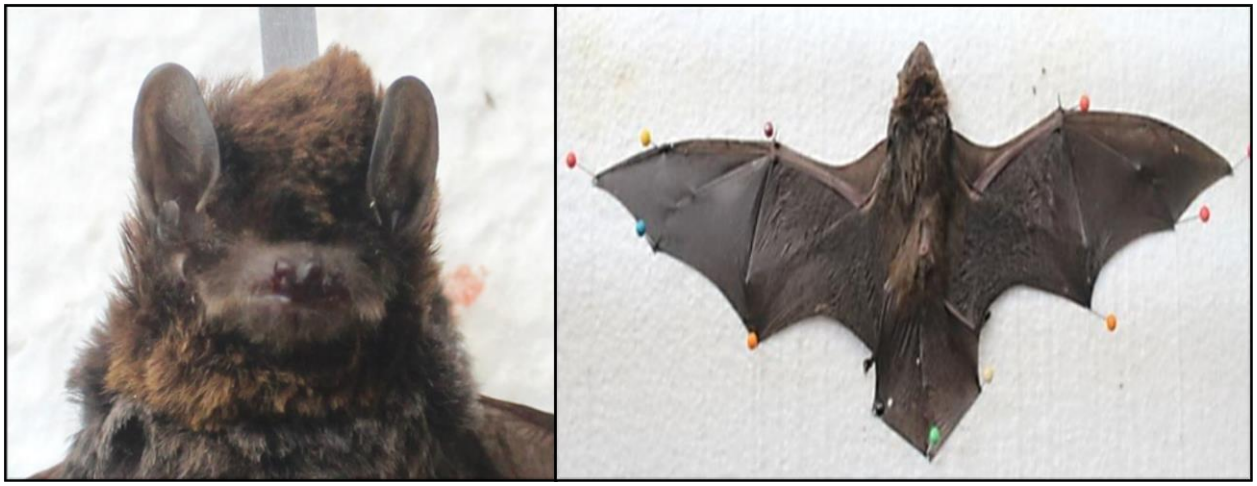

Figure 4. *Miniopterus schreibersii* (Common bent-wing of the Family Vespertilionidae).

Figure 5. *Rhinolophus subrufus* (Small Rufuos Horsheshoe Bats of Family Rhinolopidae)

M. schreibersii of the Family Vespertilionidae has dark brown fur that is longer over the shoulder and top of the head than elsewhere on the body; its wings bends and folds back tightly against the adjacent portion of the wings. According to Nowak (2007), *M. schreibersii* is on the IUCN red list for low risk, near-threatened species. This species is considered mainly endangered in Western Europe, but possibly throughout the world. Colonies that had contained thousands of individuals have disappeared. It is especially sensitive to disturbances and may be locally eradicated if disturbed by human workers or tourists. All of the vespertilionids in the Philippines are insectivorous. They eat up insects to half of their body weight each night. Their diets include mosquitoes and pests of important crops such as rice and corn; hence, they must be conserved.

On the other hand, *R. subrufus* of the Family Rhinolopidae has a reddish dorsal fur but slightly pale brown on the ventral part. The noseleaf is slightly wider than the muzzle. *Rhinolophus subrufus* has been recorded from the Philippines (island of Luzon, Mindoro, Negros and Mindanao), with specific mentions in the provinces of Abra, Zamboanga del Norte and Zamboanga del Sur, Mindoro, Negros, Polillo and Samar and Siquijor (Heaney *et al*., 1998). It has been recorded between 200-1,500 masl (Table 2).

Table 2. Population estimate of caving dwelling bats in Pader Cave, Barangay Victoria, Zamboanga City.

Species	Estimated no. of individual bats in an area
Miniopterus schreibersii	7,025
Rhinolophus subrufus	3,657
TOTAL	10, 682

The total estimated number of insect bats recorded reaches 10, 682. *Miniopterus schreibersii* has greater population estimate (7,025) than *Rhinolopus subrufus* (3,657). Vespertilionids, in which the *M. schreibersii* belongs to, is an exceptionally large and diverse family. Species that roost in caves often forms large colonies, ranging from hundreds to tens of thousands (Ingle & Heaney, 1992). The lesser number of populations of *Rhinolopus subrufus* is supported by the works of Heaney *et al.* (1998); their study states that rhinolopids roost in caves in fewer numbers only and are known to be uncommon and rarely recorded in the country (Tanalgo & Hughes, 2018). The physical parameters (temperature, humidity and light intensity) were also obtained to be able to assess ecological suitability of the Pader Cave as a habitat of the bats. Table 3 shows the average physical parameters inside Pader Cave during the 3 consecutive visits. Figures 7-8 shows the observed human disturbance in the area.

Table 3. Mean physical parameters taken in Pader Cave, Zamboanga City.

Physical Parameters	Mean
Temperature	32.2°C
Humidity	90%
Light Intensity	-001

Physical parameters play an important role in the population of insect bats. These physical parameters were believed to be very important in sustaining life on the cave. According to Sedlock and Ingle (2010), the temperature and humidity inside the cave remain constant and when bats roost together in large numbers their body heat keeps them warm which is especially important to young bats. If the humidity and temperature are cold or not suitable for them, they tend to migrate to warmer areas where food is available (Sherwin *et al*., 2012).

Light-intensity obtained is -001, which means that there is no light; simply, total darkness prevails inside the cave. Light intensity is a factor that affects the levels of bat foraging activity. Most species of bats are nocturnal and they emerge from roosts around sunset, when the natural light-intensity diminishes (Wilkins, 2012). Figure 6 shows some of the observed human activities inside the Pader Cave such as vandalism, while the dead bats are also believed to be a result of hunting and cut stalactites.

Figure 6. Some observed human disturbances inside Pader Cave (vandalisms, dead bats believed to be a result of hunting and cut stalactites).

The stable environment in caves offers a relatively suitable habitat for many bat species in the Philippines; however, these observed human disturbances may lead to extinction of some species even before they are documented (Tanalgo & Hughes, 2019). This is supported by the works of Tanalgo and Tabora (2015) which states that human encroachment imperils many of the species roosting in the caves even before they are scientifically documented and explored. Ingle *et al.* (2011) further stated that the collection of guano of cave bats inside the cave is rampant as an alternative source of fertilizer. Some also search for some hidden treasures, collect edible swiftlet nest as a nido soup, and for entertainment. Threats in caves are generally anthropogenic in nature including subsistence and tourism (Tanalgo *et al*., 2016).

CONCLUSION AND RECOMMENDATION

Two (2) species of insect bats were seen roosting in Pader Cave, Zamboanga City. These species are: *Miniopterus schreibersii* belonging to Family Verpertilionidae (or evening bats); and *Rhinolophus subrufus* belonging to Family Rhinolophidae (or horseshoe bats). The study also estimated a total number of 10, 682 individual insect bats inside the Pader Cave, Barangay Victoria, Zamboanga City. *Miniopterus schreibersii* is the most populated with a total number of

3,657. With the observed human disturbances made in Pader Cave, such as bat hunting and vandalisms, it is recommended that this cave should be managed to minimize bat population disturbances, especially during the season when bats are being born and are still feeding on their mothers. The locality should be informed of the importance of cave conservation through Communication Education and Public Awareness (CEPA) materials for conservation activities, sustainability, as well as for biodiversity concerns.

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