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Troglofauna Species in Su'bon Cave, Matanao, Davao del Sur, Philippines: Classification and Conservation Status

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Abstract
This study investigates the biodiversity, classification, and conservation status of cave-dwelling animal species in Su'bon Cave, Matanao, Davao Del Sur, using a quantitative-descriptive methodology. Data collection involves meticulous observation, permission acquisition, extensive fieldwork, and the utilization of the DENR assessment book and Schiner-Racovitza system for species categorization. The IUCN Red List also plays a crucial role in assessing the conservation status of each species. Findings reveal twelve distinct species, including Giri Putri cave crabs (*Karstama emdi*) and Egyptian fruit bats (*Rousettus aegyptiacus*). Species classification indicates no troglobionts, two stygobionts, five troglophiles, and five trogloxenes. In terms of conservation status, four species remain unevaluated, five are "least concern," two are "vulnerable," and the Giri Putri cave crab is "critically endangered." Thus, this study underscores the urgent need for conservation, particularly for the critically endangered species in Su'bon Cave. It also highlights the potential for future research and comprehensive evaluations to protect these unique cave ecosystems. Strong recommendations are made for preserving cave-dwelling species and their habitat through strategic conservation initiatives and sustained research endeavors.

Keywords
Biodiversity assessment, Cave-dwelling species, Conservation status, Schiner-Racovitza system

INTRODUCTION

Ecosystems are fundamental units of ecological study as they represent the dynamic balance of life and natural processes. The essence of an ecosystem lies in the intricate web of interactions among living organisms and their physical environment. For lots of compelling reasons, studying ecosystems is fundamental. It is crucial to comprehend these ecosystems to record, conserve, and safeguard this great diversity of species. Without an in-depth understanding of these advantages and the ecosystems that offer them, we are unable to effectively address the global concerns of resource management and environmental sustainability.

One of the most unique ecosystems on Earth is the cave. The significance of cave ecosystems is remarkable. These subterranean environments are notable for being unique and frequently fragile. Because they are home to species that have evolved to survive in hostile environments like darkness, scarcity of food, and restricted space, caves provide an extraordinary insight into the world of biodiversity. Caves are essential in our attempts to document and comprehend the diversity of life since many of them are home to rare species.

According to the National Cave and Karst Research Institute (2023), caves are essential to humanity in various ways. They give scientists knowledge about the earth's natural resources, its geologic past, its human history, and its

evolutionary process. Caves hold important information on the world climate, groundwater supplies and contamination, and biomedical studies. Contrary to the emerging studies that deal with ecosystems, research, and public attention are disproportionately concentrated on species and habitats that are considered charismatic, while other similarly diversified systems like caves and underground ecosystems are frequently neglected in biodiversity assessments and priority setting. A significant portion of the endemic species found in caves may still be undiscovered, highlighting the urgent demand for protection (Tanalgo et al., 2022).

In terms of status, cave ecosystems are seen as one of the extreme cases of these overlooked but deeply influential features, but they are underrepresented in conservation planning and implementation around the world and have become mostly overlooked in conservation strategies overall (Medellin et al., 2017). In addition, Sugai et al. (2015) seconded this motion given that most conservation assessments and landscape analyses are based on vegetation cover, forest fragmentation, and other above-ground ecosystem features, while subterranean ecosystems tend to be underrepresented or ignored in conservation plans and protected areas. Though certain existing studies dwell on the conservation of caves, few cave maps are available, and relative to the hundreds of thousands of caves in the world, only a few regions—including Europe, Puerto Rico, some caves in Canada, some states in the United States, Australia, the Philippines, and a few others—are protected areas for caves, as cited by Medellin (2017).

Seeing the poor conservation and protection planning of caves around the world, there are also alarming factors that need to be considered aside from the gap itself, as it greatly affects the ecosystem and fauna inside the cave. Due to their peculiar environment, caves are highly vulnerable to both natural and human-made disturbances and are under numerous environmental pressures, as mentioned by Mammola et al. (2019) like how human activities such as deforestation and industrialization significantly degraded environmental conditions, leading to a substantial impact on global climate change (Danyal et al., 2022). As cited by Mendellin (2017), the most frequent threats to caves, which are relatively more vulnerable than other ecosystems, are urbanization, doline development, soil erosion, groundwater pollution, and vandalism, as well as disturbances posed by cave tourism (Cigna, 2016) and economic-environmental interests like mining (Sugai, 2015).

Cave mining is considered one of the threats to cave ecosystems worldwide. For instance, Brazil has 13,816 registered caves, but only 11.6% of them are in strictly protected areas, while 75.6% are in regions with mining potential. Thus, only 6% of all caves in Brazil are protected, and only in strictly protected areas that are not near any mining interests (Sugai, 2015). In the Philippines, the impact of economic-environmental threats is strong, like in the case of a raided cafe inside a cave in Sitio Langub, Barangay Baganihan in Davao City, where authorities discovered severed damaged limestones that are two million years old, while several pieces of furniture and electrical configurations were also found inside the cave. According to the Department of Environment and Natural Resources (DENR), the cafe operated without a permit, as reported by PTV News (2023).

Another threat is the case of tourism activities inside caves. Cigna and Forti (2013) stated that several caves were transformed into tourist destinations in later centuries; these are known as "show caves," which are defined as "any cavity where a fee is paid to gain access to and visit them," and the integrity of the cave ecosystem, including all of its environmental elements, is threatened by these structural and environmental changes as well as by the presence of visitors (Piano, 2022). From the structures of the caves themselves, for instance, the temperature of the cave (both in the air and the water) may be directly impacted by the presence of visitors (Sebela and Turk, 2014). Visitors to the cave spread microorganisms found on speleothems and dust pollutants through their clothing and hands (Iliev et al., 2018), in the air, water, and the ground's sediments (Martin-Sanchez et al., 2014; Ando and Murakami, 2020; Kukla et al., 2018).

Mentioning tourism, studies on the implications of tourism on cave invertebrates are limited, as noted by Pacheco et al. (2020), with the majority of studies focusing on speleothems, microclimate, microbiota, lamp flora, and visitor carrying capacity. However, few studies about cave species emerged, as Isia and Piano (2022) stated that some specific examples of how tourism can affect cave species include disturbance of bats as tourists' noise and artificial lights can frighten bats, causing them to flee their roosts or have fewer offspring; cave invertebrates are harmed because they are extremely sensitive to changes in their habitat; invasive species introduction as visitors may unintentionally carry invasive species inside caverns and have the potential to spread diseases as well as compete with local cave species for food and habitat. Moreover, Pacheco et al. (2020) showed differences between the tourist- and non-tourist-friendly areas of the cave in the troglobitic species abundance and the species composition of both. The species composition and richness of troglobitic organisms are also influenced by several substrate characteristics. Lastly, it was observed that although stepping from tourism activities does not have clear effects on the species richness and composition, it changes the cave environment.

Notably, Tanago, Teves (2016), and Hughes (2018) highlighted the detrimental impact of human actions on caves across the Philippines, driven by the search for resources like food, recreation, minerals, and guano. Unfortunately, cave ecosystems were largely overlooked in global conservation strategies and were underrepresented in conservation planning and implementation, as pointed out by Lison, Jimenez-Franco, and Altamirano (2020). This underscored the urgent need for the preservation and conservation of the cave ecosystem, its resident species, and their habitats as it was at some point highlighted in the study conducted by Newja & Paul (2023) where progressive nations and some major firms are increasingly incorporating environmental policies in response to any threat in the environment and the species living in their particular habitat.

In regards to this, it is seen that the cave-dwelling species is threatened by many factors. Globally, over 15% of species that live in caves are considered to be threatened, according to the IUCN Red List of Threatened Species (2023). There are more than 200 species of bats included in this, and they are especially susceptible to disturbances and habitat loss. In addition, the following cave-dwelling species are also in danger: fish: more than 10% of species of fish that live in caves are in danger; over 20% of the species of invertebrate that live in caves are threatened; over 10% of the amphibian species that live in caves are in danger; and reptiles: 5% or more of the species of reptiles that live in caves are in danger. Relating to the conservation of these species, Phelps et al. (2016) cited that many caves endemic species are relatively small, often poorly studied, and are rarely considered in conservation priority settings, yet their habitats are under intense human pressure. The presence of a diverse range of species within this habitat underscored the potential threats posed by various human activities, such as guano hunting and ecotourism. Considering the aforementioned, there is a significant indicator for venturing into Subon Cave of Matanao, particularly in light of its troglofauna classifications and conservation status.
This study delved into two key aspects: the classification and conservation status of species within the cave. The ecological classification of cave-dwelling animals and their adaptations was outlined in the work of Howarth & Moldovan (2019). Their study introduced the concepts of troglobionts and symbionts, representing animals adapted to subterranean land or aquatic environments, respectively. Troglophiles could thrive in both underground and terrestrial habitats, while trogloxenes regularly visited burrows for sustenance and shelter. The refined Schiner-Racovitza system is a valuable tool that integrates morphology and ecology to categorize these creatures for understanding the biology and conservation of subterranean organisms (Trajano & de Carvalho, 2017). On the other hand, Dublin (2022) provided insights into the extinction assessment of various organisms and emphasized the significance of the International Union for Conservation of Nature's (IUCN) Red List of Vulnerable Species as a prominent classification system.

Creature classifications and adaptations in cave environments were explored in other studies as well (Howarth & Moldovan, 2018). Investigations into the invertebrate subterranean faunas of Southeast Asia and New Guinea garnered attention (Beron, 2015), along with research on South American cave crickets, crucial for ecological and evolutionary studies (Castro-Souza, 2023). Furthermore, Eberhard & Howarth (2021) employed the Schiner-Racovitza system to analyze cave fauna in Tropical Queensland, Australia, emphasizing its ecological context, which is often lacking in conventional species categorization.

In the Philippines, Quibod, Alviola, Guia, Cuevas, Lit, and Pasion's (2019) study about diversity and threats to cave-dwelling bats on a small island in the southern Philippines highlights the need for fundamental data on the distribution, diversity, and ecology of cave-dwelling bats in the Philippines. Moreover, Perez and Nuñez (2020) conducted a study on the species richness and conservation status of bat caves in Agusan del Sur. Unlike the Schiner-Racovitza system, their approach involved mist netting, abundance projections, and key informant interviews to determine species richness and conservation status. Species identification relied on the 2008 IUCN Red List, and comparisons were made among the threatened species lists of the Philippines, Brazil, Colombia, and China. Brito, Ambal, and Brooks (2020) revealed disparities in species categorization between national and global assessments by the IUCN. Notably, a considerable percentage of species were globally listed but not nationally, highlighting the complexities of conservation assessment.

In conclusion, the investigation of Subon Cave in Matanao highlighted the importance of species, their categorization, and conservation within distinct ecosystems. The 198-meter-deep, Class II Subon Cave has already been visited by local tourists since its opening on April 8, 2021, and is a community-based eco-tourism managed by the barangay and the Blaan community of Sitio Talambato, as reported by Matanao Tourism (2021). According to the Department of Environment and Natural Resources handbook, there are four (4) identified species in the area namely; (1) *Amblypygi,* a tailless whip scorpion identified in the assessment book as Cave Spider; (2) *Karstama emdi,* a Giri Putri cave crab identified as Cave Crustacean; (3) *Barbodes pyrpholeos,* a cave-dwelling Cyprinid fish identified as Cave Fish; and (4) *Rousettus aegyptiacus,* a Rousette fruit bat identified as Bat Cave. The investigation of Matanao's Subon Cave brought to light the significance of discovering new species, classifying them, and conserving them within distinct ecosystems. The pressing requirement for thorough preservation initiatives was accentuated, given the risks arising from human activities and the insufficient consideration of cave ecosystems in worldwide conservation approaches.

The significance of this study is that it provides new insights to the Department of Environment and Natural Resources (DENR), the Tourism Office, tourists and visitors, the scientific community, aspiring researchers, and most significantly, the residents of Barangay Asbang, as they would all benefit from this study. Department of Environment and Natural Resources (DENR)—for them to acquire the additional recorded data of this study and for them to plan, develop, and implement a national program for cave and cave resource management, protection, and conservation. Tourism Office—for them to enact proper rules and regulations in tourism activities that will aid in the preservation and conservation of the cave ecosystem. Tourists and Visitors: This will help the visitors gain knowledge of the rules and regulations of responsible cave tourism while maintaining a healthy respect for heritage, local cultures, and people. Scientific Community: As part of their responsibility to ensure the diversity of living species, it will help them to focus on studies such as protecting species in special ecosystems such as caves and further conserving their inhabitants. Future researchers should conduct further studies, particularly on how to protect and conserve species in special ecosystems like Subon Cave. People of the barangay Asbang, such as the barangay officials, tribal groups, and local citizens, for them to know the different ways to protect and conserve the cave ecosystem, specifically the cave species.

RESEARCH OBJECTIVES

The following were the research objectives for the study:

1. To determine the cave-dwelling species found in Su'bon cave, Matanao, Davao del Sur.
2. To determine the state of cave-dwelling species found in Su'bon cave, Matanao, Davao del Sur in terms of;

2.1. **Classification**

- 2.1.1 Troglobiont
- 2.1.2 Stygobiont
- 2.1.3 Troglophile
- 2.1.4 Trogloxene

2.2. **Conservation Status**

MATERIALS AND METHODS

Research Locale

On Mindanao Island, in Region XI Davao Region, Matanao is situated in the province of Davao del Sur. The municipality of Matanao is located 990 km (620 mi) south-southeast of Manila, the capital of the Philippines, and 15 km (9.3 mi) west-south-west of the province's capital City of Digos. In light of this, Barangay Asbang is one of the 33 barangays with a significant number of tourist attractions, particularly the cave ecosystem. Until they learned about the breathtaking views and more than twenty cave ecosystems, Talambato, one of its barrios, was just a plain spot. Su'bon Cave (Class II) is one of them. It is a group of caverns that are well-known as ecotourism destinations in the area, offering an alternative but sustainable form of livelihood for the villagers around.

Su'bon Cave, on the other hand, is 198 meters deep and moderately submerged in water, with larger calcite formations. Su'bon also means "foul odor" from bat feces, a smell that one can catch a whiff of inside the cave. The many formations in it will be explored during spelunking or cave exploration. Speleothems cover the sides like sheets of a waterfall, sprout from the floor like mushrooms, and hang from the ceilings like icicles. Speleothems are produced as the dissolved calcite re-hardens and acidic water releases carbon dioxide into the open areas of the cave. Su'bon caverns are known for being typically gloomy, chilly, and bat-filled, yet they also perform many important functions in establishing and maintaining a healthy ecosystem. In addition to providing a habitat for fragile and endangered animal species, they are crucial for the movement of groundwater. Its tourism status is more on leisure travel as tourists go there for recreation as well as cultural events but in terms of visitation, the site only has a few visitors during weekends but not that crowded.

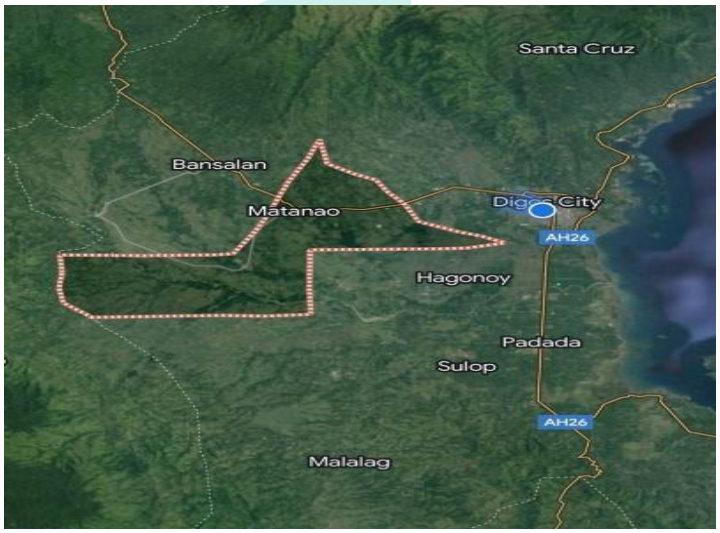

Figure 1 Davao Del Sur Map

Figure 2 Brgy. Asbang, Municipality of Matanao Map

Figure 3 Su'bon Cave Location

Research Instrument

In this study, there were two instruments used in the collection of data.

1. ***Canon camera*** **-** Cameras have several advantages over other methods of data collection in observational research. First, cameras can provide a permanent record of the behavior being studied. This allows researchers to review the data multiple times and to code the data for different variables. Second, cameras can be used to collect data without intervening in the behavior being studied. This can help to reduce the observer effect, which is the tendency of participants to behave differently when they are being observed (Doe, 2023).
2. ***Species checklist tool*** **-**, according to Mona (2022), a species checklist is a simple inventory of species that can be found in a specific geographical area given a specific time which gives necessary information on ecological studies, biodiversity assessments, conservation reports, and, other documentations and analyses relating to biodiversity. The checklist tool was comprised of three (3) matrices. Matrix 1 was the List of Species Identified in the Area; Matrix 2 was the Classification of Identified Species in Su'bon Cave and Matrix 3 was the Conservation Status of Identified Species in Su'bon Cave.

Design and Procedure

The researchers employed the quantitative-descriptive method in this study. Creswell (2008) claimed that quantitative study was a technique for assessing unbiased ideas by looking at how closely variables were associated. Then, these variables could often be measured using tools to generate numerical data that could be statistically analyzed. The writing, recording, reasoning, and understanding of the characteristics, arrangement, or process of experiences were further facets of descriptive research, in accordance with Dupan (2012). The current atmosphere, or the way in which individuals, groups, or articles behaved or worked concurrently with the research activity, was the main point of importance. Descriptive data was typically collected using survey and observational approaches, as descriptive research focused more on determining "what is" (Nabavi, 2010).

The procedures listed below were used to collect the data for this study:

First, an approval was secured from the Research Publication Office approved by the Dean's Office, allowing the researchers to conduct the study. Second, permission was sought from UM Digos College to conduct the study legally and securely. Furthermore, the researchers inquired at the Department of Environment and Natural Resources and Department of Tourism Matanao's Office about possible papers to obtain. The necessary papers and letters, such as permits, were prepared for the possible organization/person who would sign the permission. The authorization was presented to the Municipal Mayor, Barangay Officials, and other organizations. Third, the researchers traveled from Digos City to Sitio Talambato of Matanao and started the data gathering. Fourth, the observation and identification of species coming from the camera for documentation took place. This study encompassed a total of at least 3 days over 3 months of monitoring. The researchers detected the surroundings and watched the for pohabitats habitat of species.

Data Analysis

This study used the assessment book from the Department of Environment and Natural Resources, which entails all the information about characteristics as well as the whole inspection and exploration data of Subon Cave during the whole duration of the assessment, including all listed activities recorded there before it was opened to the public. It was confirmed in the data whether the particular species was seen or not during the field study. This study also utilized a Schiner-Racovitza system to categorize the troglofauna. The system was developed by two scientists, Ignace Racovitza and Franz Schiner, and it provides a framework for classifying cave-dwelling organisms based on their degree of adaptation to the cave environment. This system is important for understanding and categorizing cave-dwelling species and is still widely used by biologists and ecologists interested in subterranean ecosystems (Trajano & de Carvalho, 2017). The Schiner-Racovitza system classifies cave-dwelling organisms into four: troglobiont, stygobiont, troglophile, and trogloxene (Von Schimonsky & Bichuette 2019).

Moreover, the International Union for Conservation of Nature's (IUCN) Red List of Threatened Species of Dublin (2022) was used in this study to analyze the status of a specific species. It is a globally recognized and widely used system for assessing the conservation status of species. It provides information about the risk of extinction faced by various species and has several categories to classify their status. The system includes categories such as "Endangered," "Vulnerable," "Near Threatened," "Least Concern," "Critically Endangered," "Extinct in the Wild," and "Extinct," among others (Cazalis et al., 2022). The Red List serves as a valuable tool for governments, conservation organizations, and researchers to identify species that are at risk of extinction. This information is crucial for setting conservation priorities, allocating resources, and developing strategies to protect threatened species and their habitats (Wieringa, 2022) and (Challender et al., 2023). The most thorough source of information available on the state of animal, fungal, and plant species' global conservation is the IUCN Red List of Threatened Species. It is a vital sign of how well the biodiversity of the world is doing. The IUCN Species Survival Commission (SSC), a network of more than 10,000 scientists from around the world, creates the Red List (IUCN, 2023).

Matrix 1 International Union for Conservation of Nature (IUCN) Red List of Threatened Species

Legend:		
Threatened Categories	**NE**	Not Evaluated
	DD	Data Deficient
	LC	Least Concern
	NT	Near Threatened
	VU	Vulnerable
	EN	Endangered
	CR	Critically Endangered
	EW	Extinct in the Wild
	EX	Extinct

Ethical Consideration

This study adhered to the ethical guidelines established by the University of Mindanao Ethics Committee. The researchers secured significant letters of permission from the relevant authorities and different local organizations that took part in the study. Additionally, the researchers ensured that they were held responsible for their actions during the data-gathering process, especially because every entry into a cave, by any person, caused disruption. Even minor adjustments and disturbances, whether deliberate or unintentional, had the potential to have a significant impact on the cave's environment. Researchers also made sure to boost research validity and maintain academic or scientific integrity to guarantee the relevance of the study.

RESULTS AND DISCUSSION

Cave-Dwelling Species Found in Su'bon Cave, Matanao, Davao Del Sur

Matrix 2 shows the names and numbers of species found during the three observations at Su'bon Cave, Matanao, and Davao del Sur. There were twelve (12) species identified, each of which appeared in a different instance *(see Appendix A)* for the images.

Matrix 2 List of Species Identified in the Area

S. No.	**Common Name of Species**	**Scientific Name of Species**	**Observations**		
			Day 1 May 06, 2023 (Time: 8:00 am)	Day 2 June 17, 2023 (Time: 1:00 pm)	Day 3 July 30, 2023 (Time: 9:00 am)
1	Tailless whip scorpion	*Amblypygi*	✓	✓	✓
2	Giri Putri cave crab	*Karstama emdi*	✓	✓	✓
3	Black-spotted stream frog	*Sylvirana nigrovittata*	✓		✓
4	Cave-dwelling Cyprinid fish	*Barbodes pyrpholeos*	✓	✓	✓
5	Taman Negara Camel Cricket	*Rhaphidophora invalida*	✓	✓	✓
6	Mindanao Horned Frog	*Megophrys stejnegeri*		✓	
7	Lowland Tropical Bullfrog	*Adenomera andreae*		✓	✓
8	Blood-red ant	*Formica sanguinea*		✓	
9	Olive-green Coastal Katydid	*Austrosalomona falcata*		✓	
10	Greenhouse frog	*Eleutherodactylus planirostris*		✓	✓
11	Egyptian fruit bat	*Rousettus aegyptiacus*	✓	✓	✓
12	Beauty Rat Snake	*Orthriophis taeniurus*	✓		

Tailless whip scorpions *(Amblypygi),* Giri Putri cave crabs *(Karstama emdi),* cave-dwelling cyprinid fish *(Barbodes pyrpholeos),* Taman Negara camel crickets *(Rhaphidophora invalida),* and Egyptian fruit bats *(Rousettus aegyptiacus)* were recognized during the three (3) consecutive observations. The black-spotted stream frog *(Sylvirana nigrovittata)* was only seen during the first and third observations. Lowland tropical bullfrogs *(Adenomera andreae)* and greenhouse frogs *(Eleutherodactylus planirostris)* were all noticed during the second and third visits to the area. On the other hand, the olive-green coastal katydid *(Austrosalomona falcata),* mindanao horned frog *(Megophrys stejnegeri),* and blood-red ants *(Formica sanguinea)* were all detected during the second visit to the area only. Lastly, the Beauty Rat Snake (*Orthriophis taeniurus)* was viewed only during the first data gathering.

State of Cave-Dwelling Species Found in Su'bon Cave, Matanao, Davao Del Sur in Terms of Classification

Matrix 3 shows the classification of twelve (12) identified species based on whether they are Troglobiont, Stygobiont, Troglophile, and/or Trogloxene. There were no species identified for the Troglobiont—animals that live in tiny spaces and cracks in mesas, which are mostly made of iron ore (Hill, 2019).

Matrix 3 Classification of Identified Species in Su'bon Cave

S. No.	List of Species	Classification			
		Troglobiont	*Stygobiont*	*Troglophile*	*Trogloxene*
1	*Amblypygi*			✓	
2	*Karstama emdi*		✓		
3	*Sylvirana nigrovittata*			✓	
4	*Barbodes pyrpholeos*		✓		
5	*Rhaphidophora invalida*			✓	
6	*Megophrys stejnegeri*				✓
7	*Adenomera andreae*			✓	
8	*Formica sanguinea*				✓
9	*Austrosalomona falcata*				✓
10	*Eleutherodactylus planirostris*			✓	
11	*Rousettus aegyptiacus*				✓
12	*Orthriophis taeniurus*				✓

However, there were two (2) species classified as stygobionts—species that live in hyporheic environments, which are subaquatic habitats that are generally found near or close to riverbeds or other bodies of water (Ichter et al., 2022), and these are the *Karstama emdi* and *Barbodes pyrpholeos*. Furthermore, for species that can tolerate both cave and surface environments but may not be fully specialized for either or what we called troglophile (Oliveira et al., 2018), we have the five (5) following species: *Amblypygi*, *Sylvirana nigrovittata*, *Rhaphidophora invalida*, *Adenomera andreae*, and *Eleutherodactylus planirostris*. Lastly, the trogloxene, in which, according to Hutchison (2016), these are species that have been recognized or that occasionally enter caves but lack specialized adaptations for cave life and primarily reside outside, are these three (3): *Megophrys stejnegeri, Formica sanguinea, Austrosalomona falcata, Rousettus aegyptiacus, and Orthriophis taeniurus.*

State Of Cave-Dwelling Species Found in Su'bon Cave, Matanao, Davao Del Sur in Terms of Conservation Status

Matrix 4 shows the conservation status of the twelve (12) species identified during the data gathering. The checklist was executed with the help of The International Union for Conservation of Nature (IUCN) Red List of Threatened Species as an instrument and reliable source of information for the species because it is trustworthy for classifying species since it is put together by professionals, applies strict evaluation standards, and goes through peer review. It is consistently updated to reflect the most recent knowledge in science (Rueda-Cediel et al., 2018).

Four (4) species were identified as not evaluated (NE); these are the *Amblypygi*, *Barbodes pyrpholeos*, *Formica sanguinea*, and *Austrosalomona falcata*. According to The IUCN red list of threatened species (n.d.), species designated as "Not evaluated" (N.E.) have not yet received a thorough evaluation. This can be the result of incomplete data, a need for further analysis, or a lower priority relative to more threatened species.

Furthermore, a total of five (5) species were identified for least concern (LC) due to their extensive natural and introduced distribution, tolerance of a wide range of environments, and huge population (IUCN SSC Amphibian Specialist Group, 2021); they are not expected to be dropping quickly enough to warrant listing in a more vulnerable category (La Marca et al., 2004), and because they occur in several protected places (Monadjem et al., 2017). These species are the *Eleutherodactylus planirostris*, *Adenomera andreae*, *Sylvirana nigrovittata*, *Sylvirana nigrovittata*, and *Rousettus aegyptiacus*.

Matrix 4 Conservation Status of Identified Species in Su'bon Cave										
S. No.	**List of Species**	**Conservation Status**								
		NE	DD	LC	NT	VU	EN	CR	EW	EX
1	*Amblypygi*	✓								
2	*Karstama emdi*							✓		
3	*Sylvirana nigrovittata*			✓						
4	*Barbodes pyrpholeos*	✓								
5	*Rhaphidophora invalida*					✓				
6	*Megophrys stejnegeri*			✓						
7	*Adenomera andreae*			✓						
8	*Formica sanguinea*	✓								
9	*Austrosalomona falcata*	✓								
10	*Eleutherodactylus planirostris*			✓						
11	*Rousettus aegyptiacus*			✓						
12	*Orthriophis taeniurus*					✓				

On the other hand, two (2) species were recognized as vulnerable (VU); these are the *Rhaphidophora invalida* because of its 6,100 km2 estimated extent of occurrence (EOO). Willemse & Hochkirch (2019) quantified that a continued drop in the number of mature individuals, the number of subpopulations, and the number of sites is implied by the habitat's reported ongoing loss (7% deforestation from 2007 to 2017). The second one is *Orthriophis taeniurus*, in light of a potential population loss estimated at over 30% during the previous ten years (mostly in China) as a result of excessive exploitation for the food and skin trade (Li, Zhou, & Ghosh, 2021).

The Giri Putri cave crab fits the requirements for classification as critically endangered because it has an area of occupancy (AOO) of less than 0.003 km2, is only known from one place, and its habitat is immediately at risk due to unchecked and expanding tourism and religious practices (Whitten & Ng Kee Lin, 2015). However, the near-threatened (NT), data-deficient (DD), endangered (EN), extinct in the wild (EW), and extinct (EX) statuses had no species to be classified.

CONCLUSION

Based on the analyzed data, results, and discussion, the researchers conclude that there are twelve (12) identified species in Su'bon Cave that are found in different areas, times, and instances. These are Tailless whip scorpions *(Amblypygi)*, Giri Putri cave crabs *(Karstama emdi)*, cave-dwelling cyprinid fish *(Barbodes pyrpholeos)*, Taman Negara camel crickets *(Rhaphidophora invalida)*, Egyptian fruit bats *(Rousettus aegyptiacus)*, black-spotted stream frogs *(Sylvirana nigrovittata)*, lowland tropical bullfrogs *(Adenomera andreae)*, greenhouse frogs *(Eleutherodactylus planirostris)*, olive-green coastal katydid (Austrosalomona falcata), blood-red ants *(Formica sanguinea)*, and lastly, Beauty Rat Snake *(Orthriophis taeniurus)*. In terms of its classification, among the twelve species, five (5) are identified as Troglophile, and another five (5) species are found to be Trogloxene. Through thorough identification, the researchers found out that there are no species identified as Troglobiont; however, the remaining two (2) species on the list are said to be Stygobiont based on the Schiner-Racovitza system.

Furthermore, in terms of its conservation status, the researchers conclude that four (4) species are identified as not evaluated (NE), five (5) species were identified for least concern (LC), two (2) species were recognized as vulnerable (VU), and lastly, one (1) species named Giri Putri cave crab is identified as critically endangered (CE). With these data, the researchers concluded that the Su'bon is in need of intensive conservation and planning for the protection of the species inside the cave so that the not evaluated (NE) species can be used for further studies for thorough evaluation, the least concern (LC) and vulnerable (VU) species can be protected, and lastly, the critically endangered one can be preserved and guarded because its conservation status is seemingly alarming to one of its kind.

Based on the aforementioned findings, the local government should establish a monitoring program to track the population dynamics, distribution, and behavior of the identified species within Su'bon Cave. This will help in assessing how these species adapt to changing environmental conditions and human impacts over time. Thus, by means of conducting a comprehensive study of the cave's microclimate, including temperature, humidity, and light conditions, to understand how these factors influence the distribution and behavior of the identified species; this could further investigate the ecological interactions among the identified species within the cave.

More so, such conservation measures could also develop conservation strategies for the species inhabiting Su'bon Cave, particularly those classified in their threatened categories (vulnerable and critically endangered) as well as in assessing the threats they face, such as habitat degradation, pollution, or disturbance in order to raise awareness about the significance of Su'bon Cave's biodiversity and the need for its protection as one of the wonders in the Province of del Sur.

While this study has successfully identified twelve species within Su'bon Cave, there may still be unidentified species hidden within this unique ecosystem. Such recommendation on further extensive assessment for undiscovered species is highly suggested, as this can contribute significantly to further understanding of Su'bon Cave's biodiversity and

enhance its conservation efforts, safeguarding these hidden treasures for future generations. With this kind of move, through sharing findings and collaborating with regional and local biodiversity databases and institutions, this can facilitate cross-referencing and verification of newly identified species in future researches.

Furthermore, in order to gain a deeper understanding of Trogloxene species with regards to their interactions with this subterranean environment and their role in the broader ecological landscape, a comprehensive ecological study of Trogloxene species in Su'bon Cave is recommended as this can inform conservation efforts and enhance our appreciation of the unique relationships between surface and cave ecosystems.

This research further recommends that the identified species in this study which were not yet identified by the previous researchers of the Local Government Unit of Matanao be added to their assessment book for them to have additional data for their future endeavor in the field of research especially on the Troglofauna species in the Su'bon Cave.

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DECLARATION OF CONFLICT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

Images of Troglofauna Species Identified

Picture	Common Name	Scientific Name	Matanao Tourism Office Assessment Book Identification
	Tailless whip scorpion	*Amblypygi*	Cave Spider
	Beauty Rat Snake	*Orthriophis taeniurus*	Not identified
	Giri Putri cave crab	*Karstama emdi*	Cave Crustacean
	Black-spotted stream frog	*Sylvirana nigrovittata*	Not identified
	Cave-dwelling Cyprinid fish	*Barbodes pyrpholeos*	Cave Fish
	Taman Negara Camel Cricket	*Rhaphidophora invalida*	Not identified
	Mindanao Horned Frog	*Megophrys stejnegeri*	Not identified

	Lowland Tropical Bullfrog	*Adenomera Andreae*	Not identified
	Blood-red ant	*Formica Sanguinea*	Not identified
	Olive-green Coastal Katydid	*Austrosalomonaf alcata*	Not identified
	Greenhouse frog	*Eleutherodactylus planirostris*	Not identified
	Egyptian fruit bat	*Rousettus aegyptiacus*	Bat Cave