Cave macro-invertebrates in Linao, San Isidro, Davao del Norte, Philippines

Harvey S. Salaga

Department of Natural and Physical Sciences, College of Arts and Sciences, University of Southeastern Philippines, Davao City, Philippines. Corresponding author: H. S. Salaga, salagaharvey@gmail.com

Abstract. Macro-invertebrates have an important role in maintaining the stability of the wide niches of faunal assemblage of caves. This study was conducted to determine the diversity and relative abundance of macro-invertebrates inside of an unexplored cave in San Isidro, Davao del Norte. Sampling was done through a combination of methods: visual search and direct counting methods. Eleven species of macro-invertebrates belonging to six orders were recorded. *Cyclophorus linguiferus*, *Lamarckiella mindanaensis* were found only in the entrance and *Sundathelpusa* sp. was found the most abundant species inside the cave. The highest species richness and abundance were found in the thickest guano deposit. The cave has low diversity index. Disturbances present in the cave seem to have affected the species and individuals.

Key Words: *Sundathelpusa* sp., *Stenomelania*, guano deposit, cave fauna, diversity, abundance.

Introduction. Caves are recognized as the world's most remote and fragile wilderness (Jones 2009). Caves serve as home for wildlife, which is among the most delicate and unusual habitat for humans. Cave habitats are usually deprived of light and with almost constant geographical and ambient factors (temperature, saturated humidity), and low energy input (Biswas 2010). Caves and underground habitats are dwelling places for an endemic and rich but also fragile invertebrate fauna, whose existence is mainly dependent on outside autotrophic food webs. Comparison of caves faunas is a difficult engagement; different caves are inhabited by different invertebrates (Paoletti et al 2009). Among several factors, the distribution of cave organisms is mainly influenced, especially by the potential food source (Ferreira et al 2000). In caves of Mindanao, several studies were performed, in order to account the macro-invertebrates species richness. Recent published reports on cave diversity of macro-invertebrates in Mindanao were on crickets (Lagare & Nuñeza 2013; Novises & Nuñeza 2014), spiders (Enriquez & Nuñeza 2014) and cockroaches (Mag-usara & Nuñeza 2014). This study aimed to determine the relative abundance and diversity as well as to determine the existing threats to the cave fauna.

Material and Method. Kasilak Cave is situated in the Municipality of San Isidro province of Davao del Norte, Mindanao Island with a coordinates of 7°43'39.06" N and 125°41'02.29" E. The cave has a single opening above the ground that serves as the entrance and the exit of the cave with an opening of about less than 1 meter wide (Figure 1). Access is a little difficult due to its narrow passageway. The cave length has a total 154.60 meters long with irregular small sections (Parcon et al 2015). Cave formations such as stalactites, stalagmites, flowstones and rimstone dams were observed inside the cave. Sampling was conducted on April 18-20, 2014 and May 21-23, 2014. Sampling was conducted every morning from 06:00h to 12:00h and in late afternoon from 14:00h to 16:00h. A visual-search sampling method was done in this study. Macro-invertebrates presence were searched thoroughly chambers, crevices, holes and at the floor. Captured specimens were placed in plastic containers with 70% ethanol for preservation, for later identification.

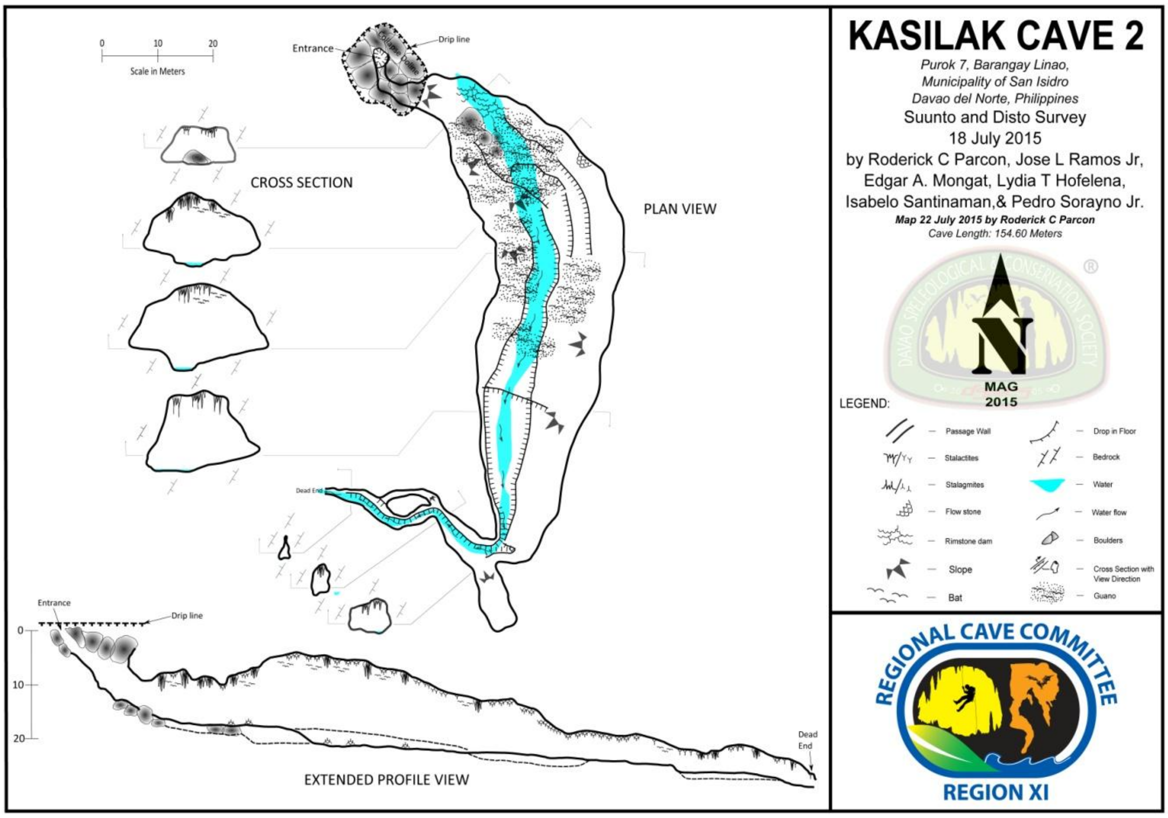

Figure 1. Cave map and survey of Kasilak Cave 2 (Parcon et al 2015).

Results and Discussion. Eleven species of macro-invertebrates belonging to six orders were identified in Kasilak Cave, San Isidro, Davao del Norte (Wildlife Gratuitous Permit-WGP No. XI-2014-03, Department of Environment and Natural Resources Region XI). These include one species of *Charon* sp. (whip spider), two species of tarantula *Selenocosmia* sp. and *Phlogiellus* sp., one species of *Heteropoda* sp. (huntsman spider), one species of *Sundathelpusa* sp. (freshwater crab), two species of land snails *Cyclophorus linguiferus* and *Lamarckiella mindanaensis*, three species of freshwater snails *Stenomelania clavus*, *Stenomelania punctata*, *Stenomelania sobria* and one species of *Ceuthophilus* sp. (cave cricket) (Table 1).

Species abundance in different cave zones. The eleven species of macro-invertebrates recorded in this study (see Table 1), were found to be abundant in the transition zone except for two species, *C. linguiferus* and *L. mindanaensis* that may have been washed out from the surface into the cave entrance. This indicates that species present in the transition zone were often associated with the guano deposits. *Stenomelania* species were found to be scattered in all zones but were abundant in the muddy substrate of the transition zone. The inflow of water due to the heavy rain could be the reason for the abundance of *Stenomelania* sp. in Kasiak Cave, a direct biotic-abiotic relationship. According to Weckerly (2012) cave crickets are often keystone species in cave ecosystems because they often occur in large numbers. Thoroughly these insects, allochthonous resource inputs are provided for caves such as their guano that sustains invertebrate communities. In the study of Novises & Nuñeza (2014) in the caves of Siargao Island *Ceuthophilus* sp. had the highest abundance with 56.93% and was widely distributed in eight out of ten caves studied.

Macroinvertebrates found and photographed in Kasilak Cave 2 are shown in Figure 2.

Table 1

Relative abundance and species diversity of macro-invertebrates

Family	*Macro-invertebrate species*	*Zone A*	*Zone B*	*Zone C*	*Zone D*	*Total*	*Total RA*
Charontidae	*Charon* sp.	4 (1.311)	1 (0.328)	1 (0.328)	0 (0)	6	1.967
Theraphosidae	*Selenocosmia* sp.	0 (0)	1 (0.328)	11 (3.607)	0 (0)	12	3.934
	Phlogiellus sp.	0 (0)	1 (0.328)	2 (0.656)	0 (0)	3	0.984
Sparassidae	*Heteropoda* sp.	0 (0)	2 (0.656)	1 (0.328)	0 (0)	3	0.984
Gecarcinucidae	*Sundathelpusa* sp.	19 (6.229)	23 (7.541)	62 (20.328)	9 (2.951)	113	37.049
Cyclophoridae	*Cyclophorus linguiferus*	1 (0.328)	0 (0)	0 (0)	0 (0)	1	0.328
Helixarionidae	*Lamarckiella mindanaensis*	0 (0)	1 (0.328)	0 (0)	0 (0)	1	0.328
Thiaridae	*Stenomelania clavus*	8 (2.623)	2 (0.656)	2 (0.656)	2 (0.656)	14	4.590
	Stenomelania punctata	12 (3.934)	5 (1.639)	9 (2.951)	8 (2.623)	34	11.146
	Stenomelania sobria	22 (7.213)	11 (3.607)	27 (8.852)	17 (5.574)	77	25.246
Rhaphidophoridae	*Ceuthophilus* sp.	0 (0)	10 (3.279)	27 (8.852)	4 (1.311	41	13.443
Total individuals		66	57	142	40	305	100.00

Values in table represent the number of individuals; Values in parentheses represent relative abundance.

Figure 2. Macroinvertebrates photographed inside the Kasilak Cave 2 (original).

Deep zone (Zone D) had the least number of macro-invertebrate species with 40 individuals from 5 species (Figure 3). It was primarily dominated by *Stenomelania* species. Zone A (entrance zone) had a greater number of macro-invertebrates compared to Zone D (deep zone). It had 66 individuals from 7 species. Crabs and snails were observed to be abundant in the entrance zone up to transition zone since water body was present. *C. linguiferus* was observed only in this area. It is reported that species under this order are distributed to warm habitat forest canopies that were observed within the surface area (Bartsch 1939). It was considered trogloxene or temporary visitors of the cave since they were only observed once during the sampling period. Zone B (twilight zone) had 58 individuals from 10 species. *L. mindanaensis* was also observed only in this area. Biswas (2010) reported that on several occasions, various trogloxenes have been recorded closely associated with the entrance and twilight zone of the cave same as the *C. linguiferus* and *L. mindanaensis* that was reported only in the two subsites. It considered an extension of the transition zone in which a little amount of guano accumulations and formation of rimstone dams are observed in this area. *Selenocosmia* sp. and *Phlogiellus* sp. were observed to dwell in this area hunting invertebrates.

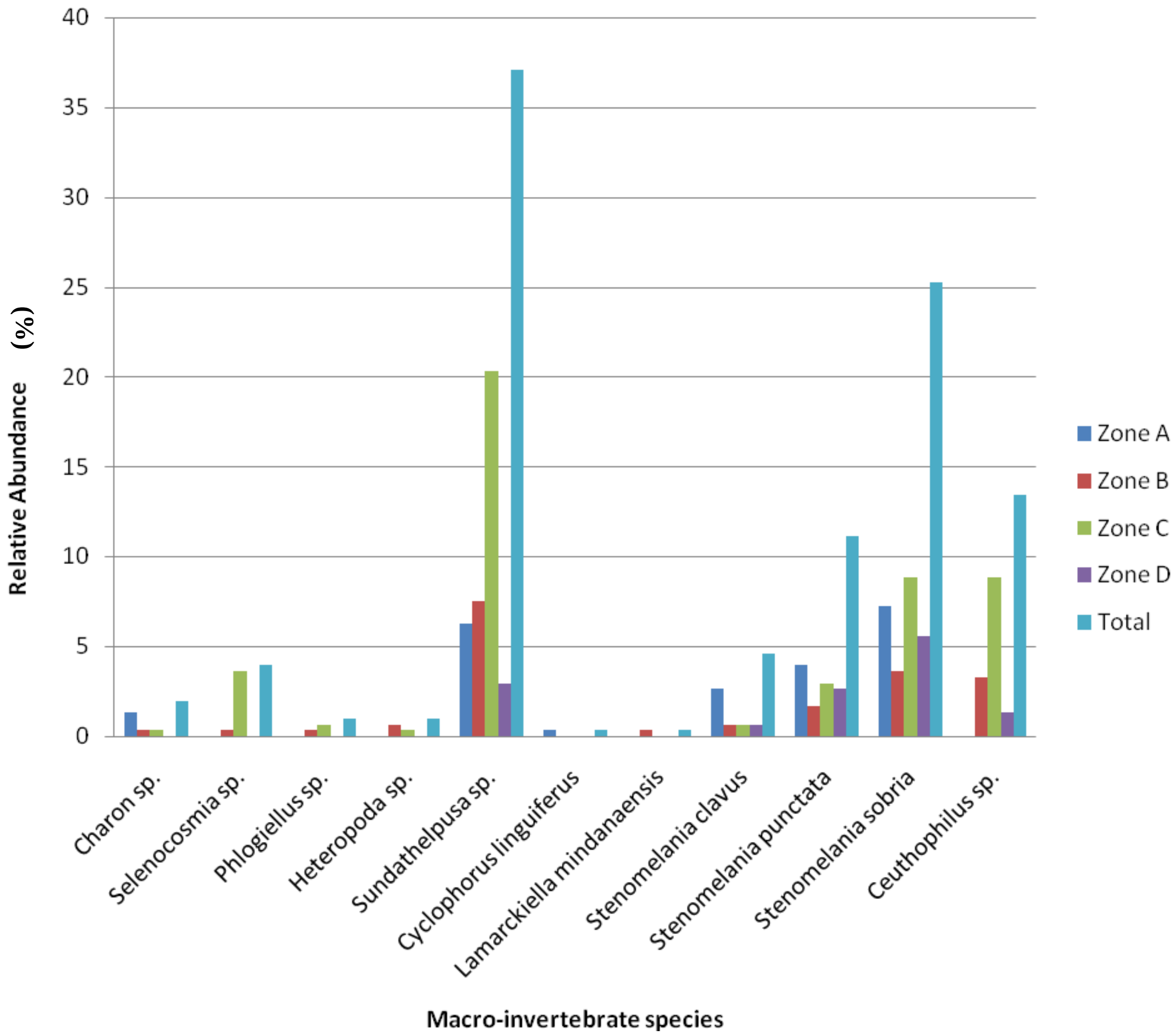

Figure 3. Relative Abundance of cave macro-invertebrates in different cave zones.

Zone C (transition zone) had a higher number of macro-invertebrates compared to all subsites. It had 141 individuals from 11 species. Guano deposits represent a rich food source for organisms particularly for invertebrates. Thus, abundant guano as food source in cave supports high population densities of macro-invertebrates (Iskali 2011; Sedlock et al 2014). The crabs dominated the area and were observed in the pools of water inside the cave. *Sundathelpusa* sp. may be considered a cave adapted species which was found to be scattered in all zones. In the Philippines, the genus *Sundathelpusa* is among the most diverse and well represented genera, with 29 out of 37 known species found, and endemic to the Philippines (Husana et al 2015). The whip spider *Charon* sp*.* was also abundant and widely distributed from the entrance zone to the transition zone. The presence of prey may be one of the main factors for the abundance of whip spider in all caves. Horvath et al (2005) stated that prey availability can influence the density and diversity of spider assemblages.

Biodiversity indices. Table 2 shows the biodiversity indices, temperature, and relative humidity of the cave zones. The four zones were found to have moderate species diversity with highest diversity in the transition zone with a total of 11 species recorded and least in the deep zone where only 5 species of macro-invertebrates were observed. In the study conducted on macro-invertebrates in Lanao del Norte (Macud & Nuñeza 2014) zones with thick guano deposits were abundant with macro-invertebrates. In the study conducted on Siargao Island, Surigao del Norte, almost all species of cockroaches

(Mag-Usara & Nuñeza 2014), spiders (Cabili & Nuñeza 2014), and crickets (Novises & Nuñeza 2014) were found abundant in the guano deposit area; this is in accordance with the results of the present study. Abundant guano sources support a considerable number of macro-invertebrates and their diversity can also be correlated with substrate heterogeneity (Chapman 1983). In the present study, species were more or less evenly distributed in the four zones (A, B, C, D) of the cave.

Table 2

Biodiversity indices, temperature, relative humidity in Kasilak Cave

Specification	*Zone A*	*Zone B*	*Zone C*	*Zone D*	*Total*
Species	7	10	11	5	33
Individuals	66	58	141	40	305
Shannon	1.514708	1.745816	1.826728	1.401213	1.925631
Temperature (ºC)	28	28	27	31	-
Relative humidity (%)	71	73	74	71	-

Existing threats to Kasilak Cave. The entrance zone was very prone to disturbance. It was observed to have remains of few alcohol drink bottles containing kerosene that were used as light source every time the residents enter and some aluminum. During the interview of local communities around the cave it was found out that most of the time residents visited the cave to hunt for bats as "pulutan" snacks eaten with alcohol drinks. Based on the information from local guides, another threat to the cave is the collection of guano for agricultural purposes where guano is used as fertilizer in the farms. The anthropogenic factors (visiting the cave, recreational activities, pollution) may directly affect the cave fauna leading to disturbance in species populations and might affect the cave microclimate, nutrient inputs, and migration of cave fauna (Eberhard 2001).

Conclusions. Kasilak Cave is an area of high macro-invertebrate abundance with low to moderate diversity index. Area with rich guano deposits was observed to have high macro-invertebrate abundance. Also, guano extraction and frequent visitation of residents to hunt bats are some factors affecting the macro-invertebrate population in the different zones of the cave.

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Author:
Harvey Salas Salaga, University of Southeastern Philippines, College of Arts and Sciences, Department of Natural and Physical Sciences, Philippines, 8000 Davao City, e-mail: salagaharvey@gmail.com

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