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Assessment of the Biophysical Conditions of Caves Promoted for Ecotourism in Mabinay, Negros Oriental, Philippines

Five caves promoted for ecotourism in Mabinay, Negros Oriental were studied by a team composed of researchers, cave guides, and professional cavers to determine their viability for tourism and impact of caving activities. Several criteria were used including assessment of threats to bats and bat cave inhabitants. Cave assessment was supplemented with interviews of local residents. Results of the study indicated that all five caves were utilized by bats as roosting sites but were disturbed by hunting and caving activities. At least 11 species of bats were found in the study area. Of the five caves, three adjoining caves were identified as ideal caving destinations for moderate cavers. One cave is recommended for extreme caving activities, and another one for special cave destination (bat cave habitat viewing). Recommendations to improve the current cave tourism are provided.

Introduction

Ecotourism in ecologically sensitive areas should support the conservation of biodiversity on which it depends, for it is now clear that nature-based form of tourism has become a major source of revenue for local communities and has augmented funds supporting the management of protected areas (Catibog-Sinha & Heaney, 2006).

One form of ecotourism presently being developed on the island of Negros is caving. This rugged form of outdoor activity is usually engaged in by physically able sports enthusiasts who are skilled in climbing and rappelling. In Mabinay, caving is done by amateurs and professionals. Aside from these strenuous caving activities, photography and leisure visits have grown in popularity (Uy, personal communication).

The increase in the number of untrained cave explorers visiting the caves of Mabinay prompted the municipality to develop easy means of access to the caves. At one popular cave destination steel walkways for visitors were constructed. These walkways also prevented them from making unnecessary contact with the fragile cave structures.

However, infrastructure development and the alteration of caves were not subjected to an environmental impact assessment. The absence of such assessment has led to some speculation that negative impacts have occurred as a result of these activities. To rule out this speculation, a study was undertaken in November 2006 to determine the present condition of the five major caves promoted for ecotourism and to establish a proximate baseline. The study was undertaken by members of the Mabinay cave guide group, researchers, and representatives of the local tourism office.

Review of Related Literature

Ecotourism as jointly defined by the Philippine Department of Environment and Natural Resources (DENR) and Department of Tourism (DOT) is "a low- impact, environmentally-sound and community-participatory tourism activity in a given natural environment that enhances the conservation of biophysical understanding and education and yields socio-economic benefits to the concerned community." This form of tourism has been largely dependent on the natural resources. As a major service-oriented industry in the country, it has attracted some 2.2 million visitors and generated almost 3 billion US dollars in gross income in 1997 (Libosada, 1998).

At least 2,500 caves throughout the Philippines have been listed by the DENR with several more being discovered and utilized by caving enthusiasts and individuals exploiting the resources inside the caves ((DENR Annual Report, 1994 and Libosada, 1998). On Negros island, at least 20 caves have been identified by European cavers in the central parts of Mabinay and Kabankalan (Slangen, 1991). Of these 20 caves, five are presently being promoted for caving by the Mabinay local government and has drawn close to 1,000 visitors generating about 60,000 pesos in 2006 (Mabinay Tourism Office, 2006).

Under Republic Act No. 9072, known as the National Caves and Cave Resources Management and Protection Act, the DENR is tasked to take the lead role in conserving, protecting, and managing natural wealth and heritage, including caves and cave resources. The task is undertaken in coordination with the National Museum (NM), National Historical Institute (NHI), the DOT, and local government units (LGU). Among the several functions delegated to DENR and its coordinating agencies are the conduct of nationwide planning, monitoring and evaluation of the implementation of the Cave Act through the protected Areas and Wildlife Bureau (PAWB); the forging of a memorandum of agreement (MOA) with any local government unit, other

government agencies, non-government organization, peoples' organization, academe, and other concerned entities for the preservation, protection, development and management of caves; and coordination or collaboration with concerned government agencies, non-government organizations, peoples' organizations, academe, and other concerned agencies in the conduct of cave assessment (DENR CAVE Act implementing rules and regulations, 2003). The Cave Act also provides guidelines for classifying caves (see DENR Memorandum Circular 2007-04).

The environmental impact statement (EIS) system promulgated through Presidential Decree No. 1586 by the late president Ferdinand Marcos is a policy that promotes a rational balance between socio-economic growth and environmental protection. The lead agency tasked to implement this order is the DENR. Among the several regulatory functions of the lead agency is to require project proponents to undertake environmental impact studies prior to project implementation, and to comply with the established environmental quality standards (Oposa, 2002; Feliciano, Tolentino, Labitag, Gloria, & Oposa, 1992). The EIS system is important because it provides critical baseline information on which mitigation measures are drawn from and implemented, especially after a negative impact has occurred (Asian Development Bank, 1996).

Methodology

Study area

The study site is located in central Negros Island (coordinates: 9° 39.63' N, 122° 59.12' E), in Barangay Bulwang, about 10 km southeast of Mabinay. It is a relatively flat limestone landscape dotted with caves and underground river systems.

The study focused on five large caves (caves with chambers measuring at least 15 m in diameter) promoted for ecotourism by the local government of Mabinay. These are Mambajo 1 (length 326 m; depth 35 m), Odluman (length 8,870 m; depth 82 m), Panligawan (length 143 m; depth 22 m), Pandanihan (length 282 m; depth 25m), and Crystal caves (length 165 m; depth 8 m). Cave length measurement is based on distance from cave opening while depth measurement is based on vertical distance from ground surface. Mambajo 1 cave has a permanent river flowing through it while Odluman cave receives water in its outer chamber during rainy season. The three other caves do not have streams flowing through them. Except for Mambajo 1, the other four caves are within close proximity to each other and are found within the reforestation site of the DENR.

Methods and Approach

The study involved training of participants in the assessment of the caves and the identification of cave-dwelling bats. Emphasis was made in training the participants to collect and identify bats, evaluate cave conditions,

and orally present their findings to stakeholders. Cave-dwelling bats were used as indicator species in the biophysical assessment because of their propensity to inhabit caves and their prominence in the Philippine vertebrate literature. The five-day training was conducted from November 22-26, 2006.

Bat identification and population estimates. To identify bats, participants were taught how to collect and process live animals. This method involved the use of monofilament mist nets measuring 3cm x 3cm. The nets were set up in cave openings and flight paths. Netting was supplemented with direct observations on bat roosts during daytime. Captured individuals were identified using the bat key of Ingle and Heaney (1992), photographed, and marked prior to their release. Total bat population in a cave was determined by estimating the number of bats occupying a unit area (that is, 1 square meter) and then multiplying this value by the total number of one-square-meter areas occupied by the bats. Seventeen net nights were spent in the study area. In addition to this, on-the-spot interviews were conducted to supplement observations.

Assessing caves as viable tourist sites. Viability of the caves was based on three main criteria: (1) accessibility, (2) biophysical conditions, and (3) safety (refer to assessment tool used in the exercise).

- Accessibility was used as a major criterion because of the rugged karst limestone conditions of the area. The relative distances of the caves from the highway, the conditions of the footpaths leading to the caves, and the relative sizes of the cave openings were rated. This criterion assumes that the more accessible the cave, the better for the tourists.
- The biophysical criterion refers to the physical and biological features of the caves that determined their ability to attract tourists and visitors. It focused on the different attractive physical features of the caves including stalactite and stalagmite formations. It also took into consideration the exploratory aspect of the caves by rating their discoverable features. The criterion also assessed cave wildlife diversity (primarily bats) as indicator species and was supplemented with interviews to determine threats to the bats and their cave habitats, among others.
- Hazard and cave obstacles or safety assessments were made to determine presence of geophysical features that could threaten the safety of cave visitors. It took into consideration flooding episodes inside the caves and other conditions that could prove risky and hazardous to cave visitors.
- Cave use merely qualified the pattern of cave use in the area. This was supplemented with interviews from the locals utilizing the caves. The different uses of the caves were identified but not quantitatively analyzed (i.e., economic use valuations) due to time constraints.

Each criterion contained parameters that were scored from 1-3, with 3 as the highest score. The total accumulated scores from all three criteria were converted to percentage to define the viability of the cave. A score card summarizing the caves' viability, in percentage, was used in ranking the five caves. A team of 2-3 evaluators assessed each cave and the results presented

to the main group (cave guides and facilitators) who critiqued and validated the findings. The three teams took turns reporting and validating each other's report.

Results

Observed bats and threats to bat population. Eleven species of bats were observed in the training sites (Table 1). These include 5 species of bats belonging to the Suborder Megachiroptera (fruit bats) and six species belonging to the Suborder Microchiroptera (insect-eating bats). The cave habitat with the most number of bat species observed is Mambajo 1 cave (9 species) while Crystal and Pandanihan caves had the least number of species observed (1 species each with few individuals). This cave (Mambajo cave) also has the highest number of aggregating bats (ca 4,200 individuals) and was dominated by the Common Nectar Bat or Dawn Bat (*Eonycteris spelaea*). Similarly, Odluman cave was observed to harbor fruit bats but of smaller number (ca 150 individuals) and fewer species compared to Mambajo 1 cave. Only the smaller species of fruit bats together with several species of microbats were observed to roost in Mambajo 1 and Odluman. The rest of the caves had only microbats living in them. Furthermore, the researchers noted that Crystal, Pandanihan and Panligawan caves showed indications that they were previously inhabited by several bats, as evidenced by the presence of bat stains on the cave roof.

The study found evidence of hunting in Odluman cave in the form of abandoned pieces of net and poles used for catching bats. This finding concurs with an earlier study by Alcala, Averia & Inocencio (in press) and Tababa et al. (in manuscript) which reported bat hunting in many parts of Mabinay. The bats species highly threatened by hunting are *Rousettus amplexicaudatus, Eonycteris spelaea,* and *Pteropus hypomelanus*. The first two species are cave-dwellers while the latter is known to roost also on trees.

Table 1

Bat species	Common name	Cave habitat				
		Mambajo 1	Odluman	Crystal	Panligawan	Pandanihan
Megachiroptera (fruit bats)						
Eonycteris spelaea	Common nectar bat	+++	-	-	-	-
Eonycteris robusta	Philippine nectar bat	++	-	-	-	-
Rousettus amplexicaudatus	Common rousette	++	+	-	-	-
Macroglossus minimus	Dagger-toothed flower bat	+	+	-	-	-
Cynopterus brachyotis	Common short-nosed fruit bat	++	++	-	-	-

Microchiroptera (Insect bats)						
Rhinolopus virgo	Yellow-faced horseshoe bat	+	+	-	+	-
Rhinolopus philippinensis	Enormous-eared horseshoe bat	-	-	+	-	-
Myotis horsfieldii	Common Asiatic myotis	+	+	-	+	+
Miniopterus schreibersi	Common bent-winged bat	++	+	-	-	-
Pipistrellus tenuis	Least pipistrelle	-	+	-	-	-
Hipposideros diadema	Diadem roundleaf bat	+	-	-	-	-
	No. of species present	9 spp.	7 spp.	1 sp.	2 spp.	1 sp.

- absent, + few individuals, ++ moderate nos.(hundreds), +++ many (in thousands)

Cave tourism assessment. The results of cave assessment showed that Crystal cave scored the highest (81%), followed by Pandanihan (78%), Panligawan (74%), Odluman (70%), and Mambajo (63%) (Table 2). Crystal cave scored high in terms of *Accessibility* and *Biophysical Attributes* because of the improved steps and constructed walkways (Figure 2). This cave, however, scored low on number of animals and was noted to have weak points as indicated by presence of broken pieces of stalactites detached from the cave roof. Weak points may be caused by vibration (transmitted from vehicles passing over the cave because the cave is situated close to the highway) and/or from seismic vibrations caused by geological movements. Further studies are needed to confirm this conclusion. On the other hand, Mambajo 1 (Figure 3) and Odluman caves scored high in terms of number of species of bats, but scored low in the hazards and accessibility criteria. Odluman cave has several unexplored inner chambers and passages that are relatively difficult to access.

Table 2 Score card and summary of results of cave tourism viability assessment.

Cave	Accessibility				Biophysical attributes					Hazards and obstacles			Total Score
	A.1	A.2*	A.3*	Score	B.1*	B.2*	B.3*	B.4*	Score	C.1*	C.2*	Score	
CRYSTAL	3	3	3	9	3	2	2	2	9	3	1	4	22 (81 %)
PANDANIHAN	3	2	3	8	2	2	2	2	8	2	3	5	21 (78 %)

PANLIGAWAN	3	2	3	8	1	2	3	1	7	2	2	4	20 (74%)
ODLUMAN	3	2	2	7	1	3	3	2	9	1	2	3	19 (70%)
MAMBAJO	3	1	2	6	2	2	3	2	9	1	1	2	17 (63%)

* Refer to description of parameters in the Assessment Tool at the Annex.

Table 3 Summary of cave use in all five caves visited

Cave	Cave use				
	Source of water (Washing/bathing)	Hunting and collection (guano, bat, bird's nest, etc)	Caving activities (rappelling, swimming, trekking, etc.)	Wildlife habitat (roost site)	Others
Mambajo 1	+	+	+	+	-
Odluman	+	+	+	+	-
Crystal	-	-	+	+	-
Pandanihan	-	*	+	+	Treasure hunting
Panligawan	-	*	+	+	Treasure hunting

+ present - absent * reported by local residents

Our observations on cave use (Table 3) indicated that all five caves were utilized by bats as roosting sites (species and population estimates are discussed under Bat observation and threats to their population). We also observed washing of clothes and drawing of water by local residents in Mambajo 1 and Odluman caves. We also found evidence of bat hunting in Mambajo 1 and Odluman caves and treasure hunting in Pandanihan and Panligawan caves. Although these activities were not actually observed, there was evidence of hunting in the first two caves in the form of bits and pieces of netting materials and bamboo poles left behind by hunters while indications of treasure hunting in the latter two caves was evident by the presence of dug holes. Caving activities appear to be prevalent in Crystal (Figure 2), Panligawan, and Pandanihan caves and were strongly associated with the presence of modified structures, like steel walkways and carved steps that improved accessibility. The other two caves were also known to be visited but unlike these three caves, they did not contain permanently modified structure.

Discussion

Threats to bats and their cave habitats. The number of bat species (11) observed in the caves is comparatively lower than the known number of cave-dwelling bat species in the Philippines which is about 50 species (Vermeulen & Whitten, 1999). The apparent depauperate (low number of bat species and low population for some caves) condition strongly suggests that the caves were highly disturbed. The presence of few bats amidst the numerous bat-stained roofs of some of the caves described earlier strongly suggests that at some point in time several bats (at least in the hundreds) inhabited these caves. It appears that construction activities, hunting, and or constant cave visits have driven away most of the bats. No study has been done to determine which of the several surrounding caves have served as relocation sites for these bats. But it has been noted that no existing cave habitat protection mechanism is in place. This could mean that bats may have relocated to other caves but remain threatened by hunting and disturbance. However, this suggestion needs to be further investigated.

Our observations on Mambajo 1 cave indicated that bat composition had changed as a result of loss of forest cover and hunting. Large species of bats such as the rare Negros bare-backed fruit bat (*Dobsonia chapmani*) and Harpy's fruit bat (*Harpyionycteris whiteheadi*) are no longer present in this cave. Rabor (1952) reported the presence of these two species of bats during his visit in 1948 when the cave area was still covered with primary forest. At present, only the smaller fruit bat species like *Eonycteris spp.* and some few insect bats (Microchiroptera) have been observed in this cave. The change in species composition has been attributed to (1) selective hunting of larger species, thus allowing the smaller species to predominate, (2) the disappearance of forest food plants (e.g., Pandan and berry-fruiting trees) that provide food for the larger fruit bat species, and (3) human disturbance.

Ecotourism viability of caves. The study showed that the three caves (Crystal, Pandanihan, and Panligawan) promoted for tourism are safe from floods and are relatively stable with few geophysical constraints that can pose hazards to cave visitors. A minor exception is Crystal cave, which has some weak points. This cave also contains steel walkways that improve passage for visitors but restrict them from coming into contact with cave structures. Furthermore, the three caves also contained unique and attractive geophysical structures that served as main attraction (Figures 2-5) and are located in low-lying hills with gradual slopes, making them easy to reach. Because of their close proximity, all three caves are usually visited at any one time.

Importance of caves. Caves do not only provide habitats to bats but are important sources of fertilizer (guano and phosphate rock) and other economically important resources like bird's nests that are made into soup. Guano is rich in nitrogen and phosphorous and is known to be superior over other organic materials because it is produced under cave conditions devoid of degrading factors like sunlight, wind, and the like. Furthermore, it contains

beneficial fungi and bacteria that help plants resist fungal infections when applied (Mithra, 2007). In addition, guano is utilized by other cave organisms as food and is an important material that sustains cave productivity (Wynne & Pleytez, 2005).

Conclusion

The study provides a simple method for assessing cave conditions and for initially determining (without detailed analysis) threats to bats. Although the caves were found to be viable for ecotourism, threats to the bats living inside the caves need to be considered. Moreover, these observed threats need to be further studied for researchers to generate specific and effective recommendations to address such concern.

Implications and Recommendations

The training helped in the development of the following activities to improve the cave program of the Mabinay tourism office:

- Promote cave habitat protection in caves known to be inhabited by important species of bats, such as Mambajo 1 cave which used to be inhabited by the rare Negros bare-backed fruit bat and is now inhabited by thousands of nectar-feeding bats. This particular cave can be promoted as a special cave destination for cavers interested in observing bats in their natural habitat.
- Promote the three caves - namely Crystal, Pandanihan, and Panligawan caves - for moderate caving. Their forest cover should be preserved to sustain cave humidity and provide water and moisture for the development of cave structures. In addition, cave structures like stalactites and stalagmites should be preserved and protected from destruction when building structures inside the cave. Furthermore, artificial lighting should not be introduced in caves containing wildlife. Intense and prolonged lighting can disturb cave animals, reduce moisture inside caves, and cause discoloration of the cave surface and structures due to photo-degrading activity.
- Promote Odluman Cave - the longest cave (ca 9 km) in Mabinay - for extreme caving because of its complex passages and relatively complex features. However, caution and proper advice should be given, and only professional cavers should be allowed to explore the cave.
- Conduct regular bat monitoring and cave habitat assessment. This may be done by cave guides. Reports on these activities should be submitted to the Mabinay tourism office and/or local DENR office and should be used to support policies that promote conservation and protection of bats and their cave microhabitats.
- Set up a bat educational program in the soon-to-be completed tourism information center in Mabinay. The center will provide information on

caves and bat species and their habitats. Bat information materials can be acquired from conservation groups like Haribon Foundation, Foundation for Philippine Environment, and Bat International. Bat specialists and biologists based in academic institutions like Silliman University can provide technical assistance.

- Advocate for legislation of local policies that will protect cave habitats and promote conservation of bat species. Advocacy should also include full implementation of the Wildlife Act and Cave Law.
- Incorporate wildlife conservation information as part of the cave guide groups' objective and commitment to educate clients and local communities.

In addition to the suggestions provided by the trainees, other recommendations are put forth in this study. The first is the incorporation of bat studies and habitat assessment in the environmental impact assessment of caves and limestone habitats proposed for development as indicated in the cave law and environmental impact assessment guidelines. The present cave viability assessment tool can be further improved to include baseline and additional impact parameters to suit this requirement. Second, further studies should be conducted to include threat assessment of cave bats and the investigation of bat relocation sites and other ecological studies like cave guano nutrient export and energetics. Third, socio-economic valuation of caves and cave resources in the area may be pursued. Finally, it is recommended that the criteria and parameters used be improved to coincide with ecotourism requirements and modified to fit certain research requirements. A practical way of doing this is to establish indices to serve as guide for evaluating and classifying cave types and usage.

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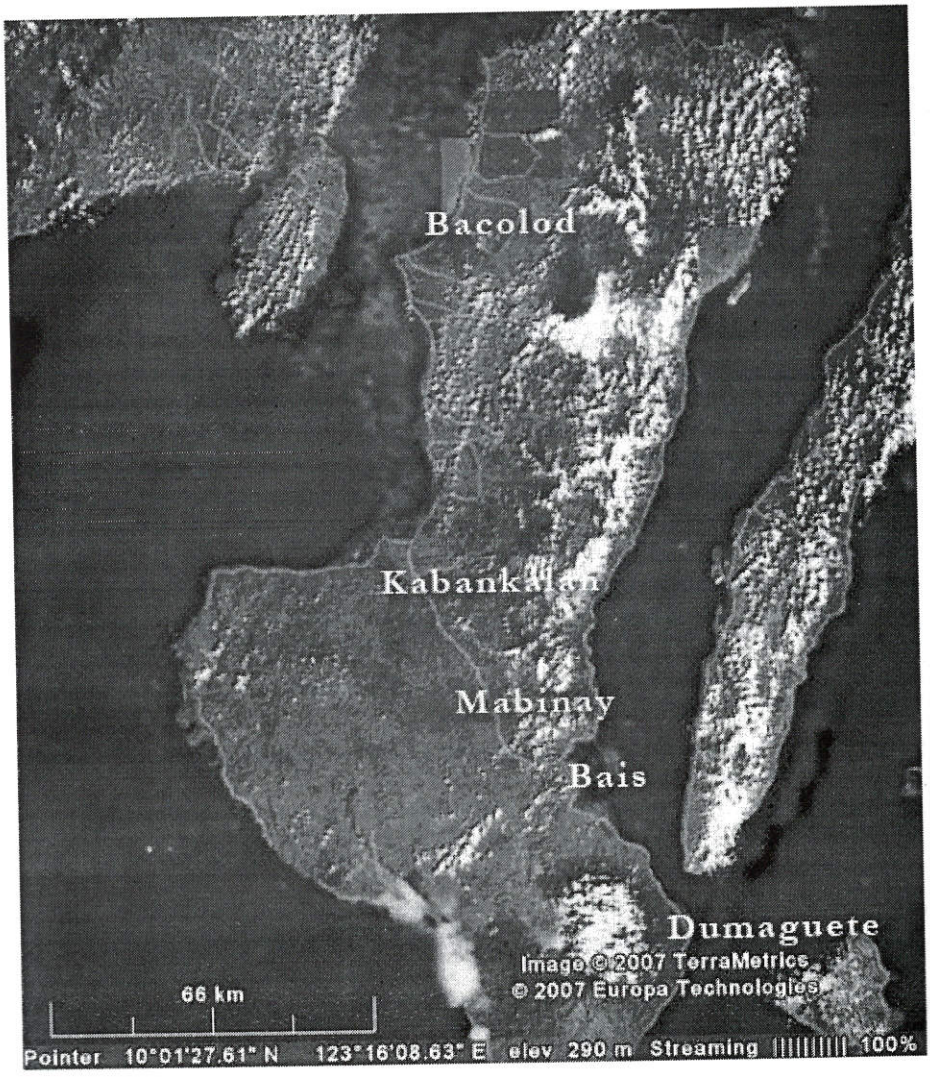

Fig. 1 Map of Negros showing location of Mabinay (Source: http://earth.google.com).

PHOTODOCUMENTATION

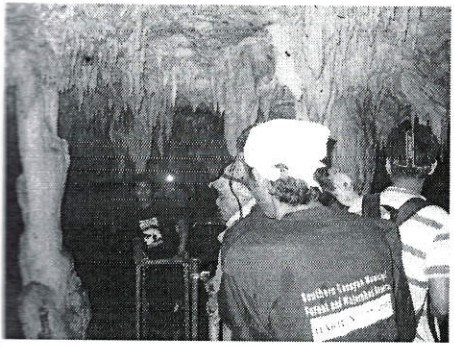

Fig. 2 Crystal cave, a cave well noted for its pristine white stalactite formations. This cave is provided with steel walk ways to facilitate passage for visitors.

Fig. 3 Mambajo 1 cave showing the large inner chamber with sky light (opening). The skylight serves as the main entry and exit for thousands of bats roosting in the chamber and is a favorite rappelling point for cave explorers.

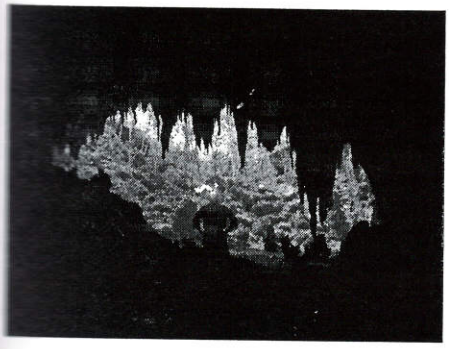

Fig. 4 Pandanihan cave viewed near the mouth opening. Steps were recently constructed leading to the cave mouth to improve access.

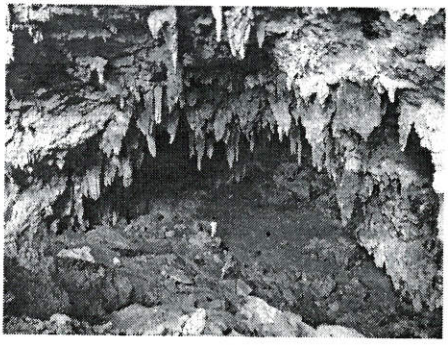

Fig. 5 Panligawan cave viewed from the surface opening. This cave has a large opening and chamber.