ASPECTS OF ECOLOGY AND THREATS TO THE HABITATS OF THREE ENDEMIC HERPETOFAUNAL SPECIES ON NEGROS AND THE GIGANTE ISLANDS, PHILIPPINES

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ABSTRACT

The nature of the microhabitats and the population density of two endemic frogs (*Platymantis spelaeus* and *P. insulatus*) and one endemic gekkonid lizard (*Gekko gigante*) were studied in southwestern Negros Island and Gigante Islands in the Visayan Sea from January 2004 to March 2005. *Platymantis spelaeus* is found only in southwestern Negros Island. *Platymantis insulatus* and *Gekko gigante* are found only in the Gigante Islands in the Visayan Sea. The study used direct observations and the quadrat technique for population counts. Temperatures and relative humidity ranges in the general environment (limestone karst rainforest) and in the microhabitats (rock crevices, rock fissures, and caves) occupied by the three species were recorded. The population density of each of the three species was found to be more than the minimum viable or effective population size for long-term fitness. The two species on the Gigante Islands are limited in distribution to the study areas, hence could qualify under the conservation status of Endangered. However, because these island populations have apparently existed for millions of years, the appropriate status is Vulnerable. The temperatures in the microhabitats were stable, in the lower 20s^{0}C, and the relative humidity ranges were 75-95%. The microhabitats ranged from moist to wet. The egg-laying sites of *P. spelaeus* (a direct developer needing moisture for reproduction) are apparently the deep rock crevices inside caves and those of *G. gigante* are the cave roofs. The main threats to the survival of the three species are direct human disturbance and reduced supply of water resulting from forest destruction and prolonged droughts.

Introduction

The Negros-Panay segment of the Negros-Panay-Cebu-Masbate Ice-Age Island (Heaney, 1986) has, among several endemic herpetofaunal species, three unique endemic species, the Gigante Gekko (*Gekko gigante,* Brown & Alcala) and the two species of ranid frogs, *Platymantis spelaeus* (Brown & Alcala) and *Platymantis insulatus* (Brown & Alcala) (**Fig. 1**). *Platymantis spelaeus* is restricted to southwestern Negros Island. It is considered Endangered under the IUCN conservation status guidelines because of its limited distribution (Alcala, E. *et al.*, 2004). *Gekko gigante* and *Platymantis insulatus* are found only in the two islands of Gigante North and Gigante South in the Visayan Sea off the northeast corner of Panay Island. *Platymantis insulatus* has been considered Critically Endangered in the Global Amphibian Assessment (www.globalamphibian.org). The conservation status of *Gekko gigante* has not been determined, but the present study indicates that it should be considered at least Vulnerable because it is restricted to the Gigantes.

Fig.1. Limestone karst herpetofauna: **A**. *Platymantis spelaeus*, **B**. *P. insulatus*, **C**. *Gekko gigante* (Photos by A.C. Alcala)


B


C

The natural habitat of these three species is the limestone karst tropical rainforest. A greater portion of southwestern Negros and the Gigantes consists of limestone rocks (also marble in the latter) and are part of the Negros volcanic arc, dating back to the Miocene Epoch (between 5 and 24 million years before Present). Karst formations are characterized by the presence of limestone or other soluble rocks like dolomite and marble and by subterranean drainage resulting from the dissolving action of water on the bedrock, and their topography is dominated by sinkholes, sinking streams, large springs and caves. Geological evidence supports the view that the islands of Negros, Panay, Cebu and Masbate formed one Ice-Age island mass when the sea level was 120 meters lower than the present level about 160,000 and 20,000 years ago during the Ice Age (Pleistocene Epoch) (Heaney, 1986).

The ancestral stock that gave rise to the Philippine platymantine frogs in the Philippines (present estimate of the number of *Platymantis* species up to 40, but only 26 are formally recognized in Alcala and Brown [1999]) came from islands of the Southwest Pacific south and southeast of the Philippines (Brown, 1997). This happened during the Pliocene-Pleistocene Epochs 5-1.6 million years ago. As presently known, the range of *Platymantis* in the Philippines includes the Luzon, Mindanao, and Visayas Ice-Age islands as well as Mindoro, Sibuyan, Siquijor Islands (Alcala & Brown, 1999). But it is absent on the Palawan and the Sulu Ice Age islands. The ancestral stock of *Gekko gigante* came from either the southeast or the southwest source areas, since the genus *Gekko* is distributed in the Oriental-Australian and eastern Palearctic regions (see Brown & Alcala, 1978).

Because of the limited distributional ranges of these three species, it was thought wise to conduct an ecological study that will assess their vulnerability to human disturbance and future climate changes manifested by such events as the El Niño Southern Oscillation (ENSO) in 1982-83, 1986-87, 1991-92, 1997-98, all of which triggered dry spells of variable durations.

Objectives of the Study

The objectives of the present study are: (1) to determine some behavioral adaptations of the three species to the limestone environment and the unique features of the limestone habitat that tend to ensure survival of the species; (2) to assess the population densities; (3) to determine the mode of reproduction of the two *Platymantis* species, as this throws light into the adaptive mechanisms for survival; and (4) to determine the threats to the continued survival of these species and to propose specific interventions to minimize the effects of these threats.

The Study Sites

There are two study sites. One is in southeastern Negros and consists of eight logged-over, open canopy (42.5% cover) limestone forest fragments with a total area of ca 345 ha at altitudes of 100-300m located in the village of Pinamay-an in the territorial jurisdiction of Barangay Camalanda-an in the municipality of Cauayan in southwestern Negros Island (Alcala, *et al.*, 2004) (**Fig 2**). The eight forest fragments studied are mostly associated with limestone karst formations characterized by the presence of caves, sinkholes, subterranean streams, and rock crevices. The general limestone karst forest and the six caves in Pinamay-an as well as some areas in the adjacent Sipalay, Hinoba-an, and Basay municipalities (**see Table 1**) have been explored in connection with this study. At least 12 species of trees of the Family Dipterocarpaceae among other species in other tree Families have been identified in the fragments.

Fig. 2. Views of Pinamay-an, southwestern Negros limestone karst rainforest (Photos by E.L. Alcala)

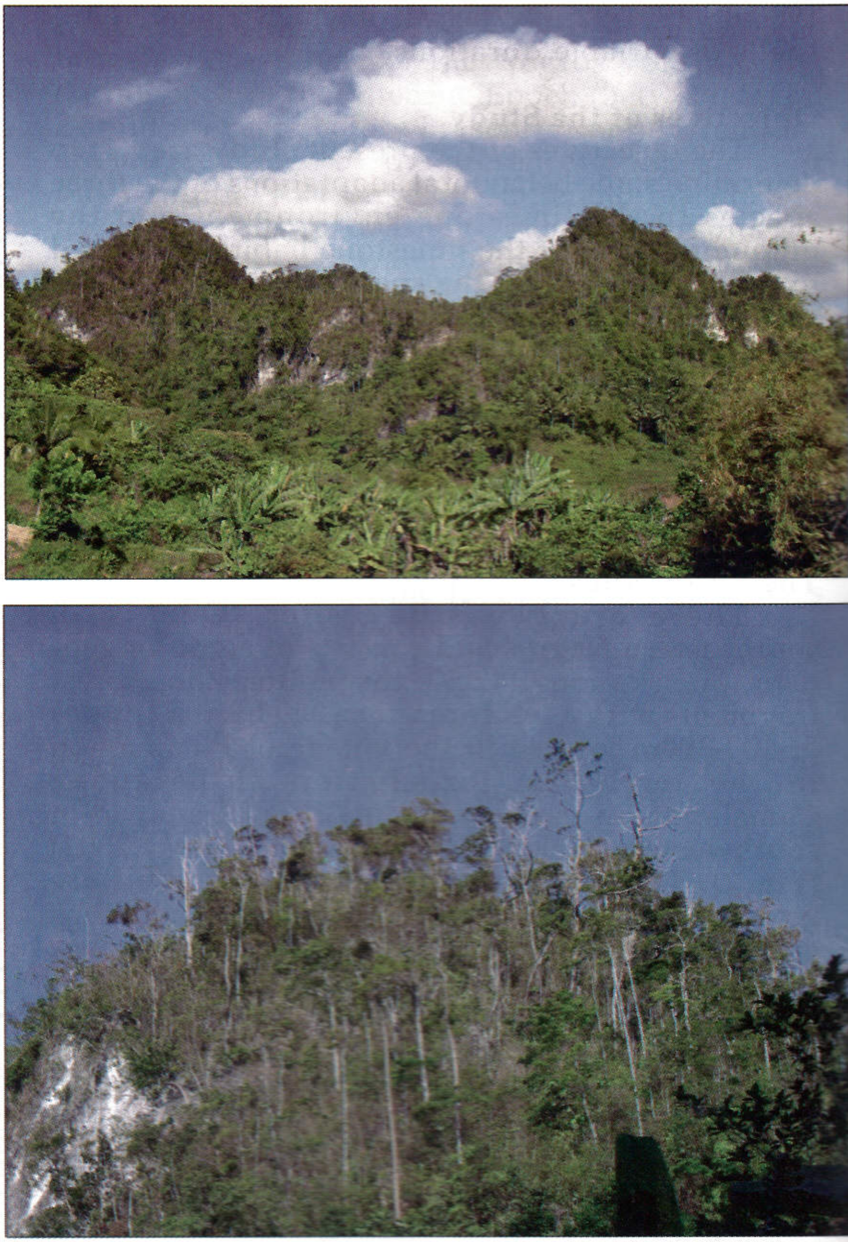


Table 1. Air temperatures (ºC) and relative humidities (%) recorded in the study areas.

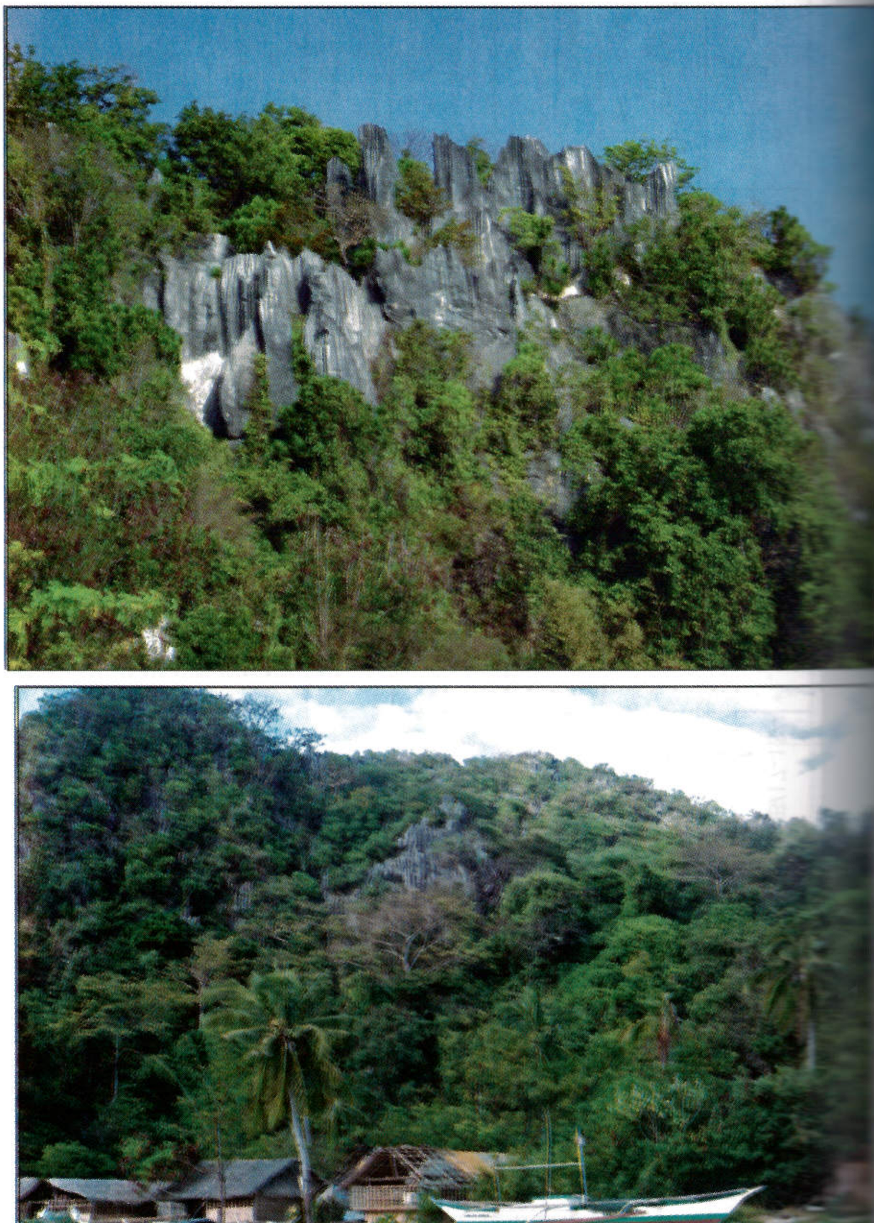
Study Site	Date	Outside Caves	Caves	Rock Crevices and Fissures	Relative Humidity	Presence/Absence of Frogs and Lizards
SW Negros	07/06/04	25			85	*P. spelaeus* active; raining;
SW Negros	07/26/04	24-25			90	P. *spelaeus* active; raining
SW Negros	08/01/04	27			90	*P. spelaeus* active
SW Negros	10/28/04	26.2	25.2	24.5	92	*P. spelaeus* active
SW Negros	11/10-11/-04	24.25	24-25		92-95	*P. spelaeus* active
Gigantes	04/30/04	29		25	67	*P. insulatus* calling
Gigantes	05/01/04	31		24	56	*P. insulatus* calling
Gigantes	09/06/04	27	26		92	*P. insulatus, G. gigante* active
Gigantes	09/08/04	31	29-30	29-29.5	65,72,78	*G. gigante* seen
Gigantes (Longon-longon Cave	03/03/05	25-26	25.5-26	23-25.5	72,75,78	*P. insulatus, G. gigante* seen

Table 1 Continued

Gigantes (Longon-longon Cave	03/03/05	25-26	25.5-26	23-25.5	72,75,78	*P. insulatus, G. gigante* seen
Gigantes (Longon-longon Cave	03/03/05	27-27.5			56,58	*G. gigante* present
Gigantes (Bakwitan Cave)110 39.948'N, 1230 20.952'E, 54mASL	03/04/05	28	25-26	23-26	82,88,95	*G. gigante* present
Gigantes(Langub Cave)110 36.463'N, 1230 20.768'E, 5mASL	03/04/05		23-28		72,72,78	*G. gigante* present
Gigantes (Pawikan Cave) 110 34.583'N, 1230 19.625'E, 16mASL	03/05/05		28-29	24-28	74,75,78	No lizards; no frogs
Gigantes (Pawikan Cave)	03/05/05	30		23-30	66	No lizards; no frogs
SW Negros (Tipulo Cave) 90 51.29'N, 1220 30.187'E, 338mASL	03/17-18/-05	26	26.5-28	22-24	78-85	*P. spelaeus, Gekko mindorensis, P. leucomystax quadrilineatus* present
SW Negros (Bangkil Cave) 90 51.342'N, 1220 29.534'E, 381mASL	03/17-18/-05	26	25.5-26	22-25	88-98	*P. spelaeus, Sphenomorphus, jagori grandis* present

SW Negros (Pulakan Cave) 90 51.275'N, 1220 29.351'E, 395m ASL	03/17-18/-05	26	24	23-24	82-96	*P. spelaeus* present
SW Negros (Ibid Cave) 90 50.898'N, 1220 29.67'E, 408mASL	03/17-18/-05	26	24-26.5	23-24.5	78-94	*P. spelaeus* present
SW Negros (Banso= Cactus Cave) 90 50.714'N, 1220 29.919'E, 408mASL	03/17-18/-05	27	23.5-25	23-25	94-96	*P. spelaeus*, *Cyrtodactylus sp.* present
SW Negros (Cambagoning Cave) 90 50.771'N, 1220 30.521'E, 426mASL	03/17-18/-05	29	24-24.5	23-24	68-95	*P. spelaeus* present

Fig. 3. Gigante limestone karst forest (top: at Baras-baras and midd Asluman); and cave at Bakwitan (next page) (Photos by E.L. Alcala, Alcala and C.Siler)



The other study site is the Gigante Islands. North and South Gigantes are almost of equal sizes with total land area of 1,300 ha. The highest elevation is ca 200 m above sea level. Very little flat land exists on the islands and mostly limited near the coastline. The topography of the Gigantes consists of limestone and marble karst **(Fig. 3)**. There are many cave systems (4 of which were explored, see **Table 1**) and rocks piled on top of each other, creating a labyrinth of spaces serving as hiding places of frogs, lizards, and other small animals. Cracks and fissures on rocks add to the variety of animal microhabitats. The vegetation consists of dwarf trees, screw pines and similar plants, shrubs and many climbing species all adapted to the rocky environment **(Fig.4)**. If dipterocarps and other hardwoods were ever present there, they must have been cut by the people now occupying the flat edges and beaches of the islands, as a survey of the vegetation failed to show any remnants of these tree species. Freshwater is scarce and is available at only two sites. These two Gigantes islands are about 20 km east of the northeastern corner of Panay Island in the Visayan Sea, a body of marine water known for its marine biodiversity and fisheries. The waters around the Gigantes and other islands are generally shallow and productive of fisheries and have been known for fisheries production since Spanish times.

Fig. 4. View of typical vegetation (Brgy. Gabi, Gigante North)

Methods and Materials
Field Visits to Study Sites

Fieldwork involving 2-5 research assistants/ observers from the Silliman University Angelo King Center for Research and Environmental Management (SUAKCREM) assisted by one or two local assistants (a total of 3-6 persons per site visit) was conducted to observe and gather environmental and biological data at the two main study sites (plus one site in southern Cebu, and one site in the area of northeastern Iloilo and

Capiz, Panay Island). The 16 site visits were spread out in 61 days from January 21, 2004 through March 20, 2005 in the following order in 2004-2005: January, February, April, July, August, September, October, November, December, and March. This way, the site visits covered the wet and dry seasons as well as the transition months between the two seasons. In terms of number of visits to the sites, five visits were made to Pinamay-an, four to the Gigantes, two to Alcoy in southern Cebu Island, two to Pilar town and Estancia town in Panay, and three to Basay, Hinoba-an and Sipalay, all in southwestern Negros Island. The Cebu and Panay sites were included in order to determine whether or not the three herpetofaunal species studied also occurred on these two islands, which formed part of the Visayan Ice-Age island.

Data Gathering

To determine the microhabitats and to census the populations of the three species studied, caves, rock crevices and spaces between rocks in Pinamay-an forest fragments and on Gigante Islands were thoroughly searched. Six caves, two in Pinamay-an and four in the Gigantes (three in North Gigante and one in South Gigante), were given much attention for population counts for evidence of reproductive activities. The coordinates of these caves are presented in **Table 1**. Sinkholes were found in the two main study sites but they were not explored because of difficulty in penetrating them. In addition, limestone rocks in Alcoy, southern Cebu Island and some limestone caves in the towns of Pilar and Estancia, both on Panay Island were also similarly searched to determine whether these three species occurred there. The adjacent non-limestone island of Sicogon was also explored for three days in February and April-May 2004.

Two methods were used to estimate population densities of frogs: direct individual counts and counts of calling males in their rocky microhabitats in forest during the rainy season at night at about seven to nine o'clock. Population censuses in caves were made at night and during the day. These censuses were based mostly on quadrats 10m x 10m or 20m x 20m. The number of calling males in a quadrat multiplied by 2 equals the total population density estimate on the assumption of 1:1 sex ratio and the assumption that all males call at census times. A check on the reliability of this method was made in a small lowland forest in Canlabac, Hinoba-an where a population census of *Platymantis dorsalis* was made using counts of calling males and counts of individuals observed from quadrats. Densities are expressed in number of individuals per hectare. The few non-calling individuals that were seen in quadrats were excluded from the counts. Quadrats were either measured or simply estimated, depending on the situation. Only visual counts during the day and at night were made for the gecko.

Two physical parameters were measured: temperatures using ordinary thermometers but checked by a quick-reading Schultheis thermometer. Relative humidity was measured by an improvised psychrometer consisting of a dry bulb and a wet bulb. Relative humidity was determined by using the dry and wet bulb readings against a published psychrometric chart.

Elevations above sea level (ASL) were determined with an altimeter. Coordinates were determined with a global positioning system (GPS).

All animals were observed alive. The few that were caught for taxonomic verification were released at their points of capture.

Only minimum disturbance, due to our movements, was made in the caves that we explored. Only flashlights were used as source of light to observe the animals and no burning was made inside caves.

Results

Microhabitats and Distribution of the Species in the Visayan Ice-Age Island

The three species studied are known to be limited to limestone karst forest formations on the islands of

Negros and the Gigantes (Brown & Alcala, 1970; 1978; 1982; Alcala & Brown, 1998; Alcala *et al.*, 2004). However, information on the nature of their microhabitats and whether they are also found in limestone karst forests of Panay and Cebu Islands was incomplete or lacking. Based on our field work reported here, the three species occur only in southwestern Negros (*Platymantis spelaeus*) and in the Gigantes (*Platymantis insulatus* and *Gekko gigante*). These three species are tentatively considered absent in limestone karst habitats in southern Cebu Island and northeast Panay Island. It is also absent on the nearby non-limestone island of Sicogon. But this negative evidence needs to be confirmed by more observations on the islands of Cebu and Panay.

Caves, rock crevices, and rock fissures are the microhabitats of the two *Platymantis* species. *Gekko gigante* has similar microhabitats but include forest trees and planted tree species bordering forests and adjacent human habitations. In caves they occupy mostly the roof crevices. The gecko is not rare in the Gigantes.

Temperature and Relative Humidity Ranges

Relatively low temperatures and high relative humidity, particularly in rock crevices, characterize the microclimate of caves that harbored the frogs (**Table 1**). The air temperatures ranged from 22-26°C (but probably mainly 23-25°C for the two forest frog species) and the relative humidity ranged from 75-95%. This microclimate probably stays stable throughout the year due to cool water dripping from cave roofs and the good air circulation. This is in contrast to higher (by a couple of degrees C) and more variable temperatures of the air and those of rock fissures and crevices outside caves (**Table 1**). Air temperature and humidity values do not differ from those of the perennially moist rainforest floor taken four decades ago. Our records of substrate temperatures in intact rainforests on Negros Island ranged from 22-24°C year round (Alcala & Brown, 1966). During the northern winter months of January and February, air temperatures may fall to 21-22°C for brief periods of time. The gecko can probably tolerate higher temperatures (up to ca 27°C), as they have been observed to be active at night at this temperature. It probably avoids caves with temperatures above 27°C and relative humidity of 65-70% or less (**Table 1**). This preference for relatively low temperatures and high humidity probably accounts for the absence of both the forest frog and the gecko in the Gigante caves during the March 2005 field observation.

Population Density

Estimates of population density of the three species studied were variable, indicating a need to refine the census methods used (**Table 2**). Estimates presented here are therefore tentative. *Platymantis spelaeus* density estimates ranged widely from about 80 to 286 individuals per hectare based on 4-7 quadrats. These estimated density range is much lower than an earlier estimate of 700-800 individuals per ha (Alcala *et al.*, 2004).

Platymantis insulatus was estimated at 400-638 individuals per hectare in samples of 3-6 quadrats but may reach about 1,000 individuals per hectare in some areas based on the number of calling males. The latter figure may be the result of the concentration of males during the calling season and is likely an over-estimate. With regard to the reliability of using calls to estimate population densities, the results of the method were tested against those derived from quadrats for another species, *Platymantis dorsalis,* which is easier to count within a small area being a surface ground species. The mean "quadrat" estimate was 220± 32 (SE) individuals per hectare (Alcala *et al.*, 2004) and the mean "call" estimate was 310± 33 (SE) individuals per hectare (unpublished data). The "calls" census method needs refinement.

Gekko gigante was estimated at 200 individuals per hectare in three quadrats in the general rocky environment. As many as 12-13 individuals were observed in caves at any one time, but it is difficult to relate these counts to area of space occupied.

Table 2. Population density estimates (Individuals/ha) of the species studied.

Species	Individuals/ha + SE Ranges	Number of Quadrats	Date
P. spelaeus	285.7 + 40.41	7	07/6-7/04
P. spelaeus	96 + 24.41	6	07/09/04
P. spelaeus	80 + 12.01	5	07/09/04
P. spelaeus	200 + 0.50	4	07/09/04
P. spelaeus	74	1	07/26/04 (in 2,700m2)
P. insulatus	606.25 + 106.25	4	09/5-13/04
P. insulatus	402	1	05/01/04 (in 150m2 in cave)
P. insulatus	1,000	1	05/01/04 (in 100m2)
P. insulatus	400 + 100	3	05/01/04
G. gigante	233.33 + 33.33	3	09/5-13/04

Reproduction

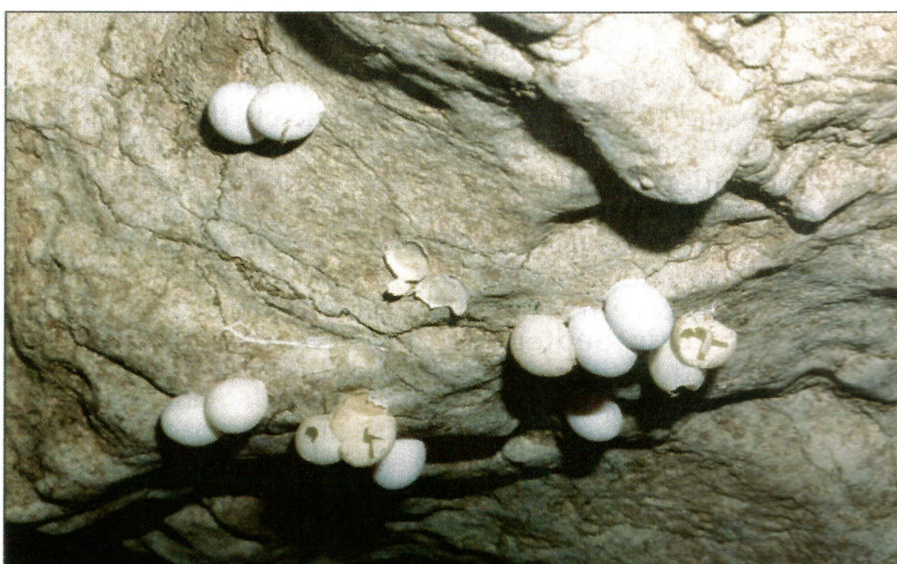
One of the objectives of this research was to study the reproduction of the three species. As it is known that some species of *Platymantis* exhibit direct development, the expectation was that the females lay large-yolk eggs that develop directly into froglets without undergoing the traditional tadpole stages (Alcala, 1962). The adaptive value of this reproductive mode is that the species can reproduce without liquid water (needing only moist nest sites), in contrast to frog species that go through the conventional tadpole stages requiring pools or running water. Our observations are consistent with the above expectation.

No egg or embryos have been observed after several months of search in the two study sites. But newly hatched froglets were seen thrice in Pinamay-an, the first time in Banso cave where two hatchlings of *P. spelaeus* were observed on October 28, 2004, the second time in Ibid cave, where 14 more newly hatched froglets still with yellowish yolk in their bellies and measuring 8-9 mm in snout-vent length were observed on November 10, 2004, and the third time in Banso cave on November 16, 2004. The froglets were found inside rock crevices and on the wet, cool rocky cave floor 3-6 m from the cave entrance (**Fig. 5**). But they could have hatched from eggs deposited in rock crevices inside the caves eight meters from the entrance, where adults, including a gravid female, were observed in one of the caves (Ibid). The egg-laying sites (rock crevices) are supplied with water dripping from stalactites. Air temperatures taken several times inside the caves remained constant at 23.5-25^0 C. at all times of the day. Relative humidity also remained high at 90-95%. The reproductive mode of *P. insulatus* is most likely similar to that of *P. spelaeus* but this remains to be demonstrated.

Gekko gigante attaches its eggs to roof of caves (**Fig. 6**). Egg-laying sites are repeatedly used. Hatchlings have distinct crossbars on the back.

Fig. 5. View of the inside of Banso cave where *Platymantis spelaeus* newly hatched froglets were seen in Pinamay-an, southwestern Negros (Photo by L. Averia)

Fig. 6. *Gekko gigante* eggs glued to roof of Langub cave in Gigante South (Photo by L. Averia)



Threats to the Survival of the Three Species

Direct and indirect disturbance of the cave microhabitats by human beings is the main threat to the survival of the three species. Diggings for presumed buried treasures, archaeological artifacts (e.g. pottery, secondary burial coffins) and guano, collection of stalactites and stalagmites, and building of fire for cooking (in Langub cave) have resulted in altered environmental conditions in these caves. The other human activity that can indirectly affect the environmental conditions in the caves is the removal of forest cover, which could in turn reduce the supply of water. Moreover, forest serves as a buffer to El Niño events. In Pinamay-an, there have been no substantial tree-cutting activities because of intensified guarding by some 30 volunteer forest guards. On the Gigantes, there is no useful purpose for clearing the forest as the area is steep and rocky, hence cannot be farmed. It is not likely that massive removal of trees will happen in the future. However, natural events such as prolonged dry season could severely reduce the populations of the three species.

The extent to which the caves in the two study areas have deteriorated as habitats of the three species is not known. However, it is probable that the decreasing trend of individual counts at Langub cave from 13-14 in May 2000 to 4 on April 30, 2004, to 7 on September 8, 2004, and to 5 on March 5, 2005 reflects the effects of smoke and human disturbance on the lizard population. In addition, several gekkonid eggs with dead embryos observed on April 30, 2004 may have been the effect of smoke. The failure to find *Platymantis insulatus* and *Gekko gigante* in Pawikan cave and in Bakwitan cave in March 2005 (**Table 1**), where they were observed in September 2004, could probably be attributed to the deterioration of the cave habitat for both species.

Discussion

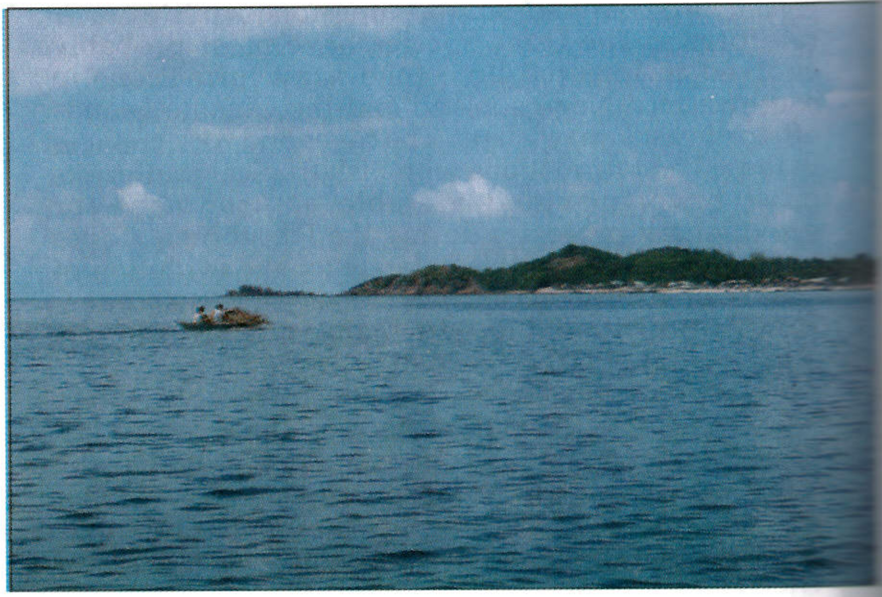
The main goal of this study is to assess the prospects for survival of these three species by determining the main features of their microhabitats, the population densities of the three species, their mode of reproduction, and the threats to their future survival. Interventions will be recommended as part of a conservation plan to be submitted to the local government units at Barangay Pinamay-an and Municipality of Cauayan and the barangays of Gigante North and Gigante South that will minimize or eliminate these threats.

Platymantis spelaeus, Platymantis insulatus and Gekko gigante are confined only to limestone karst tropical rainforests. The three species have most probably evolved in forested limestone karst formations in southwestern Negros Island and the Gigante Islands off northeast Panay Island. The caves and rock crevices in these karst formations with lush tropical rainforests must have provided a stable environment for evolutionary processes during the Pleistocene. Caves have provided favorable habitats for the evolution of species of arthropods such as crustaceans (e.g. Taiti & Howarth, 1998) and of vertebrates such as fish (e.g. Mitchell *et al.*, 1977; Roberts, 1991).

It appears that karst areas, which probably tend to retain moisture for long periods of time, can confer protection to amphibians and reptiles, provided the forest is kept intact. This is supported by the fact that four El Niño events between 1982-1998, all less than one year in duration, apparently did not show negative effects on the populations of these three species. A long term study of amphibians and reptiles in limestone forests is needed.

The three species studied are all adapted to life in limestone karst environments, where moisture tends to be conserved and temperatures remain stable at the lower $20s^0$ C due to good circulation of air. These equable environmental conditions would be maintained as long as forest cover remains intact and past rainfall patterns are maintained. The prospects for forest conservation in southwestern Negros and on the Gigantes are reasonably good because of the active volunteer forest guards in the former and the difficult terrain that discourages tree cutting in the latter. Nevertheless, one practice observed in the area that poses a threat to the scrubby limestone forest is the gathering of firewood by perhaps a thousand or more fishers using the Gigantes as base for fishing operations (**Fig.** 7). Forest conservation activities would therefore be in order in the Gigantes.

Fig. 7 Gigante fishermen transporting firewood (Photo by A.C. Alcala)



The key environmental factor that may pose a threat to the survival of the three species is rainfall, the pattern of which may have already been altered. In the past 25 years, the El Niño phenomenon, which resulted in dry climate in many parts of the country, has struck four times, and affected some parts of the country in the early part of 2005. The three species had obviously survived the dry weather spells up to our last fieldwork in March 2005. This is probably because of the relatively short duration of these episodes—generally about half a year. It is possible that El Niños of long duration such as a year or longer are detrimental to these species, as they would be to other animal and plant species as well.

In general, climate change resulting in reduced soil moisture, reduction of prey species, and development of disease has been suspected to be responsible for changes in frog breeding patterns and in amphibian microhabitats. Climate change may be a minor cause of current decline in amphibian populations, "but it can be the biggest future challenge to the persistence of many species" (Corn, 2005).

The two forest frogs studied are heavily dependent on high moisture and high relative humidity (95-100%) for maintenance of life and for direct reproduction. The gecko is probably less sensitive to lower moisture content of their microhabitats, but eggs can desiccate and fail to hatch under conditions of very low relative humidity.

Although human disturbance did affect the gecko population in one cave (Langub), human disturbance is unlikely to have a significant impact on this species since the microhabitats are found in rocky areas not readily accessible to people. In fact, the species is also found on trees near human habitations. It is probable that this species can survive under the conditions inside caves and deep rock crevices for moderate periods of drought.

The population densities of the three species, although showing wide variations, satisfy the minimum effective or viable population sizes of 500 individuals for long term fitness and 50 individuals for short-term fitness or the 500/50 rule that is generally accepted as guideline for conserving large vertebrates (see review by Shafer, 1990). *Platymantis spelaeus* has been considered Endangered (Alcala *et al.*, 2004). *Platymantis insulatus* and *Gekko gigante* should be considered at least **Vulnerable** because of their small areas of distribution in limestone forests— about 600 km^2 for *Platymantis spelaeus* (Alcala *et al.*, 2004), and no more than 1.3 km^2 for *Platymantis insulatus* and *Gekko gigante*—and because of much uncertainty in global climate change. In keeping with the generally accepted Precautionary Principle, we have to be conservative in our approach to conservation, especially in developing countries, where environment and biodiversity occupy a generally low place in the priorities of government programs.

Conclusion

If the present condition of the limestone karst forests in southwestern Negros and the Gigantes remains as is, the three species would have a good chance of surviving through time. Deforestation, exacerbated by climate change such as periodic droughts, will have serious negative impact on these species. While climate change cannot be prevented, destruction of the limestone forest can be prevented to ensure that favorable environmental conditions in the microhabitats of these species are maintained. Forests can also moderate the effects of droughts.

Five-Year Conservation Plan

Research

The initial survey will be continued to focus on habitat use, habitat indexing, and qualifying and quantifying habitat changes. Sites of egg-laying (for the two frogs) will also be determined.

Monitoring

Monitoring of the status of the populations of the three species will be made. The use of frog calls as basis to determine population density during various "calling" periods of the year will be pursued. In the case of the gekkonid lizard, direct observations will be employed. Simple monitoring methods for use by local communities and local government officials will be developed.

Critical Cave Identification

Caves used by the three species will be identified for purposes of monitoring and evaluation. The municipal councils of Cauayan and Sipalay will be asked to enact a municipal ordinance protecting these caves from human disturbance. This will require the cooperation of Local Government Units and the Department of Environment and Natural Resources for its implementation.

Information, Education and Communication

Research findings will be translated into posters, calendars, and other attractive popular publications that interpret the environment and human dependence on it. Dissemination of these materials will be through local government offices and community assemblies.

Acknowledgments

We are pleased to acknowledge with thanks the grant from the HARIBON Foundation Threatened Species Program for the financial support of this project. Leonardo Averia, Arthur Ong, Brian Peter Canlas, Noel Kimar, Rogelio Mantilla, and Cynthia Dolino assisted in the fieldwork, and we thank them for their help. We also thank Rafe Brown, Arvin Diesmos and an anonymous reviewer for their helpful comments. Jasper Leif Maypa prepared the illustrations.

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