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Species Composition and Microhabitats of Frogs within Arakan Valley Conservation Area, Cotabato, Mindanao Island, Philippines

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Abstract

Species composition and microhabitats of frogs in the Arakan Valley Conservation Area in Cotabato, Mindanao, with three interconnected mountain ranges, were documented using belt transect sampling. Frogs were sampled at 4 sites – one on Mt. Mahuson, two on Mt. Sinaka and one within the Kabalantian-Binoongan mountain range. Twenty-five frog species in 15 genera representing 5 families (Bufonidae, Megophryidae, Microhylidae, Ranidae and Rhacophoridae) were recorded, 9 of which are reported to be vulnerable. Fourteen species in 4 families were Philippine endemics, 9 of which are restricted to the Mindanao faunal region. Most species were encountered on ground microhabitats although majority of the individuals were seen on arboreal microhabitats. Overlaps in microhabitat use were also observed. Further, 56 % of the species were observed on forest edges. The high percentage of endemism may strengthen the importance of this site for conservation and the observed existence of species near edges might also highlight the conservation of all types of habitat.

Keywords: Arakan Valley, belt transect sampling, endemism, frogs, species composition

Introduction

Amphibian diversity and endemism in the Philippines is exceptionally high (Alcala and Brown, 1998; Diesmos et al., 2002a). A unique geographic history coupled with varying climatic conditions and numerous mountain ranges have contributed to this diversity (Inger, 1954). A total of 101 amphibian species have been described to date (International Union for the Conservation of Nature Global Amphibian Assessment, 2004), and new species are being discovered each year (Diesmos et al., 2002).

Several studies have greatly increased our knowledge on Philippine amphibian diversity (Alcala, 1986; Alcala and Brown, 1998; Brown et al., 2001; Diesmos et al., 2003; Inger, 1954; Taylor, 1920), but most of these are focused on Luzon and the Visayan islands. In contrast, published studies for Mindanao Island, the second largest island in the Philippine archipelago, are rare. There are 14 endemic species of frogs for Mindanao. However, because of the high speciation rates known for amphibians (Brown et al., 2001; Diesmos et al., 2002a) and the rugged mountain ranges of Mindanao which offer opportunities for diversification (Alcala et al., 1998; Brown et al., 1999) more endemic species await discovery.

One of the unstudied areas in Mindanao which may harbor high amphibian diversity is the Arakan Valley Conservation Area (AVCA). The AVCA covers three isolated mountains namely Mount Sinaka, the Mount Kimamulig Range (including Mt. Mahuson), and the Kabalantian-Binoongan forest strips within the municipality of Arakan, Cotabato Province. These mountain ranges were declared as Arakan Municipal Forest Reservation and Wildlife Sanctuary through Municipal Ordinance No. 12, which was created under Resolution No. 7, dated 19 January 1994. The name AVCA was coined by the Philippine Eagle Foundation (PEF) and refers to the whole Arakan Valley. This is the site of the PEF project, GAYNAWAAN, whose main objective was to assess vertebrate faunal diversity. These data will support the establishment of a forest corridor by identifying areas of high species diversity.

Literatures on Philippine amphibians have almost always included species composition in form of listing (Alcala et al., 1995; Brown and Alcala, 1986; Ross and Lazell, 1990) or species accounts (Brown et al., 1996; Brown et al., 2000; Diesmos et al., 2003; Gaulke, 1994). Generally these studies have resulted to new distributional records for species formerly reported in nearby islands (Brown et al., 1996, Ross and Lazell, 1990; Gaulke, 1994) or to uncovering

of frog species that are new or likely new to science (Alcala et al., 1995; Brown et al., 2000; Diesmos et al., 2003). Further these studies reported that endemism for this taxon is high and more than 50% of the species accounted were forest-restricted species. The rest are non-native species usually found in man-altered environments. Also included in the aforementioned studies are notes on microhabitat preferences. Additional information on microhabitat preferences of frogs are also found in Alcala and Brown (1987) on *Barbourula busuangensis*, Diesmos (1998, unpublished Masters Thesis) on frogs of Mt. Makiling and Mt. Banahao in Southern Luzon and Gonzales and Dans (1994) on the arboreal habitat preferences of lizards and amphibians still on Mt. Makiling. It appears that species occupy various microhabitats like streamside microhabitat, trees, epiphytes, litter and humus layers (Brown et al., 2001). Adding notes on microhabitats also proved important especially in searching species which are considered "lost species" and which where formerly known on type specimens as exemplified in the studies of Brown et al. (1996), Brown et al. (2000) and Diesmos et al. (2003). We can infer that studies on species composition and information on microhabitat preferences have actually increased discoveries of new species, and consequently increased the total number of species known. For instance, the recent discoveries on Philippine *Platymantis* (Alcala et al., 1998; Brown et al., 1997, 1999) augmented the count from 7 (Inger, 1954) to 27 species (International Union for the Conservation of Nature Global Amphibian Assessment, 2004). Moreover with the rapid discoveries not only did our knowledge on Philippine herpetofauna improved but also highlighted areas that have potential for conservation which may also aid in evaluating current conservation efforts (Brown et al., 2000; Diesmos et al., 2003)

We then attempt to present the species composition of frogs at four sites within the Arakan Valley Conservation Area. We also describe the microhabitats where samples were taken and include our observation as to whether we found species in forest interior or in edges.

Materials and Methods

Study areas

The AVCA is within the municipalities of Arakan, Cotabato and Davao City, Mindanao Island Philippines (Figure 1). The forest of Mount Sinaka, Mount Mahuson and Kabalantian-Binoongan were

once connected with those of Bukidnon. But rampant logging activities in the recent past and clearing for agriculture resulted to its fragmentation. Based on Philippine Atmospheric Geophysical and Astronomical Services Administration (PAG-ASA) climate classification, the area has Type IV climate where rainfall is generally evenly distributed throughout the year with May and June as the monsoon months. Average temperature is between 33 °C and 23 °C with December and January as the coolest months (Arriola, 1996). Amphibian diversity assessments were conducted at four sites within the AVCA.

Barangay Ganatan, Mt. Mahuson (lat 07°14.74'N, long 125°12.35'E) Located between 1260 - 1300 m.a.s.l., this site is dominantly a montane forest although it also possesses areas of "parang" vegetation especially near the edge. *Piper aduncum*, *Lantana camara* and other species of grasses, shrubs and ferns dominate the edge. *Agathis philippinensis* appear as the common emergent tree in both

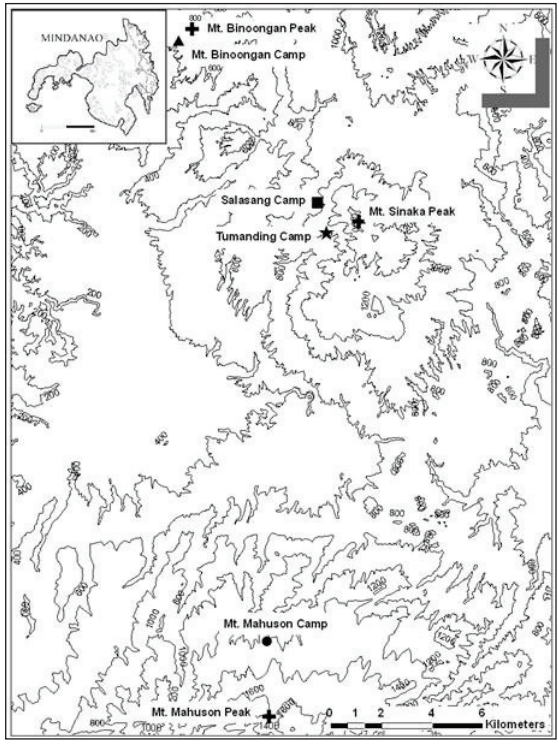

Figure 1. Map showing sampling sites and location of Mt. Mahuson, Mt. Sinaka and Kabalantian-Binoongan (Source: Philippine Eagle Foundation)

edge and interior. Tree composition doesn't vary well as one goes up with elevation although species of Podocarpaceae predominates in the higher elevation. The diameter at breast height (DBH) of tree species was estimated to be between 10 – 90 cm for canopy species and 30 - 160 cm for the emergent tree species, increasing with higher elevation. Leaf litter was thin and drier near the edge and becomes thick and moist as one approaches the forest interior. Collections were made from 15 to 24 May 2004.

Barangay Salasang, Mt. Sinaka (lat 7°22'25.7" N, long 125°12'47.7"E) Approximately 870 - 1425 m.a.s.l., this site covers three habitat types: dipterocarp, montane and mossy forest however the areas of lowland forest were vast tracts of grasslands, many of which were converted to agricultural lands. Diameter at breast heights of trees were between 30 - 160 cm (canopy trees) and 100 - 250 cm for emergent trees whereas the height of the trees range from 5 - 20 m (canopy) reaching up to 35 m for emergent trees. Tree species observed include red and white *lauan*, *marobo*, *anagdong*, *alom-alom*, *tanguile*, *nato*, *catmon*, *cinnamon*, *ulayan*, mountain *agoho*, *tinikaran* (*Leptospermum* sp.) and sagimsim. Rotting logs and small streams were abundant in this area especially as one approaches the forest interior. Leaf litter was also thick and the forest floor wet in the forest interior. Sampling was conducted from 30 July to 8 August 2004.

Barangay Tumanding, Mt. Sinaka (lat 7°21'48" N, long 125°12'59.9"E) This was the second sampling site at Mt. Sinaka, also encompassing dipterocarp, montane and mossy forests between elevations of 950 – 1430 m.a.s.l. The terrain in this site is relatively steeper than in *Barangay* Salasang. Diameter at breast height of trees is between 30 – 95 cm (canopy) and 0.6 - 190 cm (emergent) while the height of the trees fall between 6 - 20 m (canopy) and up to 30 m for emergent trees. Moss and leaf litter were observed to increase as elevation increases. *Ficus* sp., *Musa* sp. and *Pandanus* sp. were prominent in the site. Similarly, we observed that leaf litter thickness and wetness of the forest floor increases as one enters the forest interior. Fieldwork was conducted from 16 to 25 October 2004.

Barangay Binoongan Centro, Kabalantian-Binoongan (lat 7°26'9.2"N, long 125°10'8.1"E)

This site is a lowland forest covering elevations from 650 – 670 m.a.s.l. with large tracts of parang vegetation and agricultural lands. *Buyo-buyo* (*Piper aduncum*) saplings dominated the area and the terrain was relatively flat with widespread distribution of lime rocks. Limestone openings and small caves were present. Small

water tributaries were also observed in the site. The forest floor was dry and leaf litter was very thin or virtually absent. Forest floor and leaf litter conditions appear consistent in the elevation range that we sampled for this area. Collections were made from 17 to 27 September 2004.

Sampling method

A modified belt transect survey (Heyer et al., 1994) was employed. We followed the two kilometer transect established for birds placed on existing foot trails. A team of three people searched for amphibians along the two-kilometer transect, starting from the farthest point. Approximately 300 m segment of the transect was surveyed twice daily (diurnal and nocturnal walks). We also sampled five meters on both sides of each 300 m transect. Our efforts on transect walks were coupled with searches on probable breeding areas such as tree holes, buttresses and water bodies conducted within and outside the established belt transects. Transect walks and searches were conducted between 0900 – 1400 hours and 1800 – 2100 hours. For our nocturnal walks, headlamps, flashlights and torches were used. We took representative individuals of all species as voucher specimens while excess were released after identification. Ideally individuals for release must be marked using methods such as toe clipping and fluorescent dyeing (Bennett, 1999). However we never used methods for marking individuals for release and thus there is no way of ensuring that we haven't recaptured similar individuals. Samples were initially preserved in 10% formalin in the field and were later transferred to 70% ethanol for storage. For species identification, amphibian guides by Alcala and Brown (1998), Frost (2004) and Inger (1954) were used. Specimens were deposited at the University of the Philippines Mindanao.

Microhabitat classification

We classified microhabitats into three categories: arboreal, ground and aquatic. Arboreal habitats were those elevated from the ground (5 – 10 m) including branches and stems of plants, leaves and leaf axils. Ground microhabitats were referred to as microhabitats directly on the ground (0 – 5 m), or on rotting logs and tree buttresses. Lastly, the aquatic microhabitats were referred to as the microhabitats including streams, rivers, and creeks as well as standing bodies of water. We also include observations as to whether we sampled individuals in forest interior or in edges. We designate 0 – 500 m of the two-kilometer transect as the edge and 501 to 2000 m as the forest interior.

Results and Discussion

Species composition

Twenty five frog species (294 individuals) belonging to 15 genera and five families (Table 1) were documented. Fifty six percent (14 species) were Philippine endemics and 9 of these are confined to the Mindanao faunal region. Nine species of the total 25 were recorded as *vulnerable*. Samples of possibly two species of the genus *Platymantis* were also collected.

Table 1. Frog species and number of individuals recorded in Mahuson 1260 - 1300 m.a.s.l. (montane forest, 15-24 May 2004), Sinaka 870 - 1425 m.a.s.l. (lowland, montane and mossy forests, 30 July–8 August 2004), Sinaka 950 -1430 m.a.s.l. (montane and mossy forests, 16-25 October 2004), and Binoongan 650 -670 m.a.s.l. (lowland forest, 17-27 September 2004)

Species	Mahuson 1260-1300 m.a.s.l.	Sinaka 870-1425 m.a.s.l.		Sinaka 950-1430 m.a.s.l.	Binoongan 650-670 m.a.s.l.	Status
Bufonidae						
Ansonia mcgregori **	7	-		-	-	Vulnerable
Ansonia muelleri **	-	3		-	-	Vulnerable
Bufo marinus	-	-		-	1	Introduced
Pelophryne brevipes	-	2		1		
Pelophryne lighti **	-	1		-	-	Vulnerable
Megophryidae						
*Megophrys stejnegeri***	9	28		7	2	Vulnerable
Microhylidae						
Chaperina fusca	-	1	-	1		
Kalophrynus pleurostigma	4	3		3	-	
Ranidae						
Fejervarya limnocharis	-	2		-	-	
*Limnonectes leytensis**	-	-		3	-	
Limnonectes. magnus	-	-		-	1	Near Threatened
Limnonectes parvus **	-	-		2	-	Vulnerable
Occidozyga laevis	1	-		-	1	
*Platymantis corrugata**	-	6		2	-	
*Platymantis guentheri***	13	1		4	-	Vulnerable
*Rana everetti**	2	3		1	3	Data Deficient
*Rana grandocula**	-	17		20	6	
Starois natator	-	-		1	-	
Rhacophoridae						
*Nyctixalus spinosus***	-	2	1	1	Vulnerable	
*Philautus acutirostris***	67	11	10	1	Vulnerable	
*Philautus worcesteri***	-	1	-	2	Vulnerable	
*Philautus surdus**	-	-	13	-		
Polypedates leucomystax	3	4	-	8		
Platymantis sp. A	-	5	-	-	Unidentified	
Platymantis sp. B	-	-	-	3	Unidentified	
Total number of species	**8**	**16**	**13**	**12**		
No. of individuals	**106**	**90**	**68**	**30**		

Endemism: ** - Mindanao faunal region rndemic; * - Philippine endemic;

Eight frog species (n = 106) were recorded for *Barangay* Ganatan, Mt. Mahuson. More than 50 % (five species) are endemics; four are confined to the Mindanao faunal region. In terms of number of individuals, the pointed-snouted tree frog (*Philautus acutirostris*) was the most frequently encountered.

For Mt. Sinaka, 16 species (n = 90) were recorded for Salasang and 13 species (n = 68) in Tumanding. Both sites have nine species in common namely: *Pelophryne brevipes*, *Megophrys stejnegeri*, *Kalophrynus pleurostigma*, *Platymantis corrugata*, *P. guentheri*, *Rana everetti*, *R. grandocula*, *Nyctixalus spinosus* and *P. acutirostris*. Ten of the 13 species in Salasang are endemic and 10 species in Tumanding are also endemic. *M. stejnegeri* with 28 individuals was the most represented species in Salasang while *R. grandocula* (n = 20) appear abundant in Tumanding.

Twelve species (n = 30) were recorded in Binoongan, of these 6 species are endemics. *Polypedates leucomystax* (n = 8) was the frequently encountered species in this site. In all of our sites, we documented at least one of the four species (*Bufo marinus*, *Fejervarya limnocharis*, *Occidozyga laevis* and *P. leucomystax*) reported to be commensals of men (Alcala and Custodio, 1995).

Frog species composition in AVCA is a mixture of endemics and non endemics with high percentage of endemism. Each site also includes species with widespread distribution in the Philippines and those confined to the Mindanao faunal region. All the families have representative species in all the four sites. Only three species were found common to all sites: *Megophrys stejnegeri*, *Rana everetti*, and *Philautus acutirostris*.

Microhabitat

Of the 25 species documented, 56% were found on forest edges. Some of the species observed in disturbed microhabitats include: *Bufo marinus*, *Chaperina fusca*, *Kalophrynus pleurostigma*, *Fejervarya limnocharis*, *Limnonectes leytensis*, *Occidozyga laevis*, *Platymantis corrugata*, *Pelophryne brevipes*, *P. lighti*, *Rana grandocula*, *Philautus acutirostris*, *Megophrys stejnegeri*, *Starois natator* and *Polypedates leucomystax*. These results were consistent with those of Diesmos et al. (2003) who also recorded *Occidozyga laevis*, *Fejervarya limnocharis*, *Polypedates leucomystax* in human-altered habitats. Alcala and Custodio (1995) also regard *B. marinus*, *O. laevis*, *P. leucomystax* and *F. limnocharis* as species which are commensals of man and therefore it is not surprising to find these species in human-altered habitats. Given their apparent tolerance to disturbance, these species may have a better chance for survival in increasingly disturbed areas. It

is also possible that such habitat alterations provide more abundant food resources (Fredericksen and Fredericksen, 2004). Conversely, *Ansonia mcgregori*, *A. muelleri*, *Limnonectes magnus*, *L. parvus*, *Platymantis guentheri*, *Rana everetti*, *Nyctixalus spinosus*, *Philautus worcesteri*, *P. surdus*, *Platymantis* sp. A and B were confined to undisturbed or minimally disturbed habitats. Our results somehow agree with Alcala and Custodio's (1995) report where *A. mcgregori* and *A. muelleri* occupied habitats which are free or nearly free from logging and other human impacts.

Eleven species (44%) of the 25 accounted within AVCA were encountered on ground microhabitats. It appears that ground microhabitats were preferred by amphibian species in this site. Aquatic microhabitats harbored 8 species while 6 species occupied arboreal microhabitat. We further observed that some of the species have individuals occupying more than one microhabitat (Table 2).

Four of the 8 species (50%) recorded in Ganatan where encountered on ground microhabitats. However majority of the individuals were encountered in arboreal microhabitats (70 individuals). Of the species recorded among ground microhabitats, *Platymantis guentheri* appears abundant. With 67 individuals, *Philautus acutirostris* dominates the arboreal microhabitats. Lastly, of the two species recorded within aquatic microhabitats for this site, *Rana everetti* appears dominant.

At Salasang, 7 of the species were encountered on ground microhabitat and 51% of the individuals (46 samples) were also prevalently observed on the ground. In ground microhabitats, *Megophrys stejnegeri* was represented the most with 28 individuals. The dorsum of *M. stejnegeri* captured at Salasang was lighter in color (very light orange and brown pattern combination) than individuals captured at Mahuson, Napunangan (plain orange and brown), and Binoongan Centro (almost black). For the arboreal microhabitats, *P. acutirostris* was encountered frequently while *R. grandocula* appears abundant in aquatic microhabitats.

For Tumanding, 6 of the 13 species were recorded on arboreal microhabitats. Both aquatic and arboreal microhabitats harbor 25 individuals each, higher than 18 individuals encountered on ground microhabitat. Among species recorded within ground microhabitats in this area, *M. stejnegeri* still appears to be well represented. As for arboreal microhabitats, the common forest tree frog (*P. surdus*) appears common whereas *R. grandocula* still dominates aquatic microhabitats in this area and is also a well-represented species in terms of number of individuals (n = 20).

Table 2. Frog species and number of individuals recorded in Mahuson (1260 - 1300 m.a.s.l. montane forest, 15-24 May 2004), Sinaka (870 – 1425 m.a.s.l. lowland, montane and mossy forests, 30 July-8 August 2004), Sinaka (950 –1430 m.a.s.l. montane and mossy forests, 16-25 October 2004) and Binoongan (650 –670 m.a.s.l. lowland forest, 17-27 September 2004

Species	Mahuson 1260-1300 m.a.s.l.			Sinaka 870-1425 m.a.s.l.			Sinaka 950-1430 m.a.s.l.			Binoongan 650-670 m.a.s.l.		
	G	A	Aq	G	A	Aq	G	A	Aq	G	A	Aq
Bufonidae												
*Ansonia mcgregori***	7											
*Ansonia muelleri***				3								
Bufo marinus										1		
Pelophryne brevipes					2			1				
*Pelophryne lighti***					1							
Megophryidae												
*Megophrys stejnegeri***	9			28			6		1			2
Microhylidae												
Chaperina fusca				1								1
Kalophrynus pleurostigma	4			3			3					
Ranidae												
Fejervarya limnocharis						2						
*Limnonectes leytensis**									3			
Limnonectes magnus												1
*Limnonectes parvus***							2					
Occidozyga laevis			1									1
*Platymantis corrugata**				6			2					
*Platymantis guentheri***	13			1			2	2				
*Rana everetti**			2		1	2		1				3
*Rana grandocula**						17			20			6
Starois natator									1			
Rhacophoridae												
*Nyctixalus spinosus***					2			1			1	
*Philautus acutirostris***		67		3	8		3	7			1	
*Philautus worcesteri***				1							2	
*Philautus surdus**								13				
Polypedates leucomystax		3			4					6	2	
Platymantis sp. A							5					
Platymantis sp. B										3		
Total no of individuals	33	70	3	46	18	26	18	25	25	10	6	14

Microhabitat: G- ground, A-arboreal, Aq-aquatic placed in parenthesis beside each number of individuals per species per site.

At Binoongan Centro six species were documented on aquatic microhabitats and many of the individuals encountered (47%, n = 14) were also recorded in aquatic microhabitats. *R. grandocula* still appears abundant in this type of microhabitat. Arboreal microhabitats in this area appear to be dominated by *P. worcesteri* while the ground microhabitats harbor more *Polypedates leucomystax*. This species also appears to be abundant in this area having 8 individuals. Further, this species was documented in all of our sites. Very few frog calls were heard at this site.

The data generated on microhabitats suggest that amphibian species utilize multiple microhabitats for foraging, refuge against predators and maybe for reproduction as well. As generalist predators and having opportunistic foraging behavior (Santos et al., 2004), anurans may occupy a wide range of microhabitats and dwell more on areas that provide them with sufficient food supply and possibly shelter against predators. This may explain why *Philautus acutirostris* and *P. worcesteri* are observed on ground microhabitats despite their being arboreal and direct developers (International Union for the Conservation of Nature Global Amphibian Assessment, 2004). Inger (1954) also reported that insects (terrestrial and aquatic) appear to be the primary item on the anuran diet, which is typically abundant in tropical regions including the Philippines. Insects in the country appear abundant on the ground especially in areas near low-lying vegetation as well as spots where rotting fruits and decaying logs abound. All of these present an environment that allows insects to forage and thus making them available for standing predators including frogs.

Unidentified species

Two of the 25 species encountered had uncertain identities. However, based on snout-vent-length (SVL) measurements and reduced webbing in their toes, they have strong similarities to species of the genus *Platymantis* (Table 3).

Five individuals of *Platymantis* sp. A. (2 females and 3 males) were collected from vegetation near a stream in *Barangay* Salasang, Mt. Sinaka. All individuals had reduced toe webbing and irregular folds

Table 3. Snout-vent length (SVL) of unidentified samples in comparison with *Platymantis spelaeus*, *P. rabori* and *P. dorsalis* group (N = number of samples, X = mean)

	SVL of Adults (mm)		
Species	N	Range	X
***Platymantis* sp. A**			
Female	2	50.0 -50.1	50.05
Male	3	37.9 – 39.4	38.87
Platymantis dorsalis		27.0 – 53.0	
Platymantis sp. B			
Female	1	37.4	
Male	2	27.8 – 29.1	28.45
Platymantis spelaeus		41.0 – 60.0	
Platymantis rabori		27.0 – 49.0	

on the dorsum, suggesting that they may belong to the *Platymantis* dorsalis group. Dorsum color of the samples range from deep black to brown and all have asperities near vent. No calls were heard or recorded from these samples.

Three individuals of *Platymantis* sp. B. (one female, two males) were captured in limestone caves in the Binoongan Centro forest interior. These individuals were characterized by minimal ridges or irregular folds on the back, rounded digit tips and much reduced toe webbing. The samples do not have expanded toe pads. These characteristics are close to *Platymantis spelaeus* of Negros. However, the snout-vent-length (SVL) and geographical distribution is more consistent with that of *Platymantis rabori*.

Conclusions

The 25 frog species reported here to exist in AVCA is the first documentation of frog composition in Arakan, Cotabato. Fifteen genera representing five frog families were recorded. Species composition includes both endemics and non endemics. However endemism is high, as fifty six percent of the species accounted were endemics. Majority (56%) of the species recorded was found on forest edges and the species encountered include those formerly recorded to inhabit forest interiors. The species were also found to occupy varied microhabitats although most species were encountered on ground microhabitats. Overlaps in microhabitat use have also been observed among select species. The presence then of majority of the species recorded in forest edges and their use of various microhabitats may suggest that all the habitats are important. The conservation of all areas must, therefore, be given attention.

Implications and Recommendations

Our data suggest that the AVCA has a good share of frog species known in Mindanao. Unfortunately, forest loss due to illegal logging and slash and burn farming continues. There is a need to arrest loss of habitats and minimize disturbance before threats magnify and cause possible local extinctions. Many of the species documented are already listed in the IUCN as vulnerable. The results of this study also call for the improvement of conservation efforts in the AVCA. Specifically, we recommend that more amphibian inventories that employ additional survey methods (e.g., pitfall traps) and encompass all seasons be made. Collection of specimens, proper vouchering

and processing and submission of specimens to reputable museums for further taxonomic and phylogenetic studies should be an integral part of the design of future surveys. Also, further studies specifically focused on microhabitat preferences by various amphibian species are highly recommended, as this will provide important baseline information for the design of conservation zones particularly in deciding the range of habitats that must be set aside for protection to cover the diversity of frogs in a particular mountain or protected area.

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