PRELIMINARY REPORT ON THE ANURANS OF MTS. PALAY-PALAY MATAAS-NA-GULOD PROTECTED LANDSCAPE, LUZON ISLAND, PHILIPPINES

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ABSTRACT

I provide information on the anurans of Mts. Palay-Palay Mataas-na-Gulod Protected Landscape (MPPMNGPL) and its immediate vicinities based on field surveys conducted on accessible localities in 1998, 2006, and 2009. A total of 14 species representing four anuran families in 10 genera were recorded from the area. Baseline data on species richness, habitat and altitudinal distribution, and natural history of anurans are presented. The anuran assemblage exhibited high levels of endemicity (57%). Anurans were recorded in elevations from as low as 40 masl to more than 600 masl with the non-endemic species generally distributed in the lowlands while most of the endemics were restricted to higher elevations. Majority of the non-endemic species were usually associated with human-modified habitats while most of the endemic species were restricted to forest habitats. Eight microhabitat types were identified and a large proportion of anurans occurred in bodies of water and forest floor litter.

Keywords: Mts. Palay-Palay Mataas-na-Gulod Protected Landscape, Cavite province, Luzon Island, amphibian fauna, herpetofauna, distribution patterns, species richness, anuran assemblage

INTRODUCTION

Mts. Palay-Palay/Mataas na Gulod National Park was established as a wildlife sanctuary by Proclamation No. 1594 on October 26, 1976 (PAWB 1989). At present by virtue of Proclamation No. 1315 signed on June 27, 2007 this protected area is now known as Mts. Palay-Palay Mataas-na-Gulod Protected Landscape (henceforth “MPPMNGPL”) and comprises an area of 3,973.13 ha. MPPMNGPL belongs to the three prominent volcanic centers of the Cavite-Batangas Highland and this protected area is one of the best-forested area within this volcanic range. Aside from being the only established wildlife sanctuary in Cavite, it covers an estimated 62.5% lowland dipterocarp forest (DENR, 1992) and is assigned a “Very High” conservation priority level

(Ong et al. 2002) making it an important key biodiversity area on Luzon (Conservation International et al. 2006).

According to Diesmos et al. (2002) the Philippine archipelago was previously thought of as having a depauperate herpetofauna but is now recognized as one of the most important centers of herpetofaunal diversity in Southeast Asia. To date 79 of the 102 amphibian species (77%) are found only in the Philippines. However, the amphibians and reptiles of MPPMNGPL remained to be poorly known. Virtually no published literature about the herpetofauna in this area is available except for two relevant unpublished undergraduate theses of Celis et al. (1997) and Paloma and Panganiban (1998). The aforementioned works were chiefly taxonomic intended for inventory purposes. Their studies involved using a minimal sampling effort and concentrated only in one habitat type, the forest. Paloma and Panganiban (1998) collected four anuran species and three species of skinks. They also noted the population density of *P. corrugatus*. Celis et al. (1997) identified eight anuran species belonging to two families, Ranidae and the Rhacophoridae.

Beginning August of 1998 a more intensive assessment of amphibians and reptiles in the study area was conducted. It included observations on aspects of biology and ecology of these vertebrates encompassing a broad range of habitat types which consisted of lowland cultivated areas, riverine forest, and forest areas. Here, baseline data on species diversity, distribution, and ecology are presented.

METHODOLOGY

Study Area

MPPMNPL (Figure 1) is situated within the municipalities of Ternate and Maragondon in Cavite, and Nasugbu in Batangas with coordinates of 120^{o}51' east longitude and 14^{o}16' north latitude (Proc. No. 1315). It is bounded on the north by Manila Bay, west by China Sea and southeast by Mts. Cariliao and Batulao. Its topography ranges from rolling to moderately steep and steep terrain (PAWB 1989). The park contains three peaks, namely: Mataas na Gulod (622 masl), Pico de Loro (595 masl), and Palay-Palay (predominantly timberland) being the highest at 648 meters above sea level (masl) (Zanoria 1991, DENR 1992).

Vegetative cover is estimated at 62.5 percent forest (a mixture of molave and dipterocarp type) and 37.5 percent nonforest (DENR 1992). The park has been logged over and existing vegetation is considered as secondary growth forest with remnants of primary lowland forest. Some are patches of open grassland, brush, and cogonal areas, which were targeted for reforestation activities (PAWB, 1989). The park falls within the first climatic type with two pronounced seasons. The dry season is from November to April and wet during the rest of the year. August has the highest recorded rainfall and April has the lowest humidity.

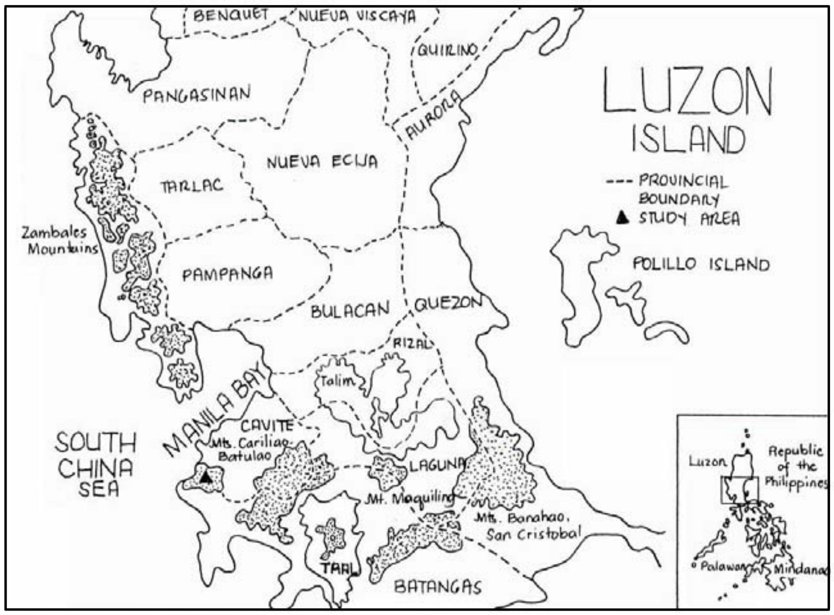

Figure 1. Map of Luzon Island showing Mts. Palay-Palay Mataas-na-Gulod Protected Landscape marked with .

Surveys were not limited to natural forests but included human-modified environments within the immediate vicinities of MPPMNGPL. The selection of six sampling sites was done based on an altitudinal gradient from as low as 40 masl (rice field) and from 300-600+ masl for both the riverine and forest habitats. Sampling was limited to accessible areas or within established forest trails in MPPMNGPL. Brief descriptions of the sampling sites are summarized as follows:

Site 1. Barangay Kaputatan, Maragondon, Cavite (40 masl, coordinates not recorded; visited, 1 September 1998, 16 November 1998, 19 December 1998). The survey site was a rice field and had an area of 100m^2. The rice plants were already harvested and the site contained mostly scattered rice straws and other plant debris submerged in the muddy soil. Several isolated pools were also observed. Some banana plants were also planted.

Site 2. Barangay Pulo ni Sara, Maragondon, Cavite (40 masl, coordinates not recorded; visited, 1 September 1998, 16 November 1998, 20 December 1998). The survey site was a stream near a rice field. The stream was bounded on both sides by vegetation consisting mainly of trees and shrubs. The stream had cool, clear, and swift flowing water. Medium-sized boulders densely covered with moss and ferns were also observed.

Site 3. Palicpican River within MPPMNGPL (300-390 masl, coordinates not recorded; visited, 1 August 1998, 5 September 1998, 28-29 November 1998, 12-13 December 1998, 22-23 December 1998, 21-22 March 2006, 29-30 March 2009, 30 April- 1 May, 2009). This site is situated within the park itself and designated as the riverine forest. Generally this area has cool, clean, and swift flowing water with scattered basins containing stagnant water with different plant and litter debris. It is bounded on both sides by the secondary growth forest and stream banks are heavily covered with moss, ferns, and shrubs. Vegetation consisting of shrubs and small trees are also interspersed among varied-sized boulders.

Site 4. Forest area (300-400 masl, coordinates not recorded; visited, 1 August 1998, 28-29 November 1998, 12-13 December 1998, 22-23 December 1998, 26-28 December 1998, 21-22 March 2006, 29-30 March 2009, 30 April- 1 May, 2009). The DENR station, which also served as our camp, is located at this elevation. This site is adjacent to the main road which is covered with tall grasses. Going inward the forest, the understory consists of a dense growth of shrubs and generally secondary growth forest.

Sites 5 and 6. Forest area (Site 5 [400-500 masl], Site 6 [500-600 masl], coordinates not recorded; visited, 1 August 1998, 28-29 November 1998, 12-13 December 1998, 22-23 December 1998, 26-28 December 1998, 21-22 March 2006, 29-30 March 2009, 30 April- 1 May, 2009). These sites are closed-canopy forest areas and generally existing vegetation is a mixture of secondary growth forest with remnants of primary lowland forest.

Field Sampling Techniques

Field techniques included a combination of transect sampling, microhabitat sampling, and tape-recording of advertisement calls (Heyer *et al*., 1994). We worked in small groups (2-4 persons) and spent most of the day and night (usually started at 1800 hr) sampling along the stream, Palicpican River, and existing forest trails which served as our transect lines for Sites 2-6; hovever, the entire area was sampled for site 1. The sampling effort was relatively equal across selected elevational gradient and habitat and microhabitat types. Surveys were also conducted in both wet and dry seasons. Specimens were captured opportunistically either by hand-grabbing or with the use of scoop nets. Tadpoles and froglets were also collected from aquatic microhabitats through dip netting. The data that were immediately taken at the time of capture included sampling date, locality, elevation, time, general description of habitat, description of microhabitat, vocalization, and the general behavior of the animal prior to collection (Heyer et al. 1994). Male advertisement calls were recorded by using a portable Sony mini recorder. Habitats and microhabitats were photographed. The captured specimens were brought to the camp (DENR outpost) for processing and preservation. Photographs of live specimens were taken to document natural coloration. The voucher specimens were fixed in 10% buffered formalin solution for one week and then preserved in 70% ethyl alcohol solution.

To aid in species identification, morphometric data were taken from preserved specimens. Other characters were noted such as color and coloration (noted prior to preservation), head shape, extent of webbing of fingers and toes, extent of digital expansions when present, shape of terminal phalanges, skin ornamentation, structure and number of tubercles on hands and feet (Brown *et al*. 1997a). The taxonomy and nomenclature of the anuran species were based on the following: Alcala (1986), Brown et al. (1996), Brown et al. (1997a, b, c), Alcala and Brown (1998), and Diesmos (1998). Voucher specimens are presently deposited at the Philippine National Museum (PNM) and Natural History Laboratory of DLSU-D.

RESULTS AND DISCUSSION

Species richness and endemicity

A total of 14 species representing four anuran families in 10 genera were recorded from the study area (Table 1). Family Bufonidae was represented by *Bufo marinus* (Fig. 2A) while Family Ranidae (Figures 2 and 3) included 10 species representing six genera namely *Fejeryarva*, *Hoplobatrachus*, *Limnonectes*, *Occidozyga*, *Platymantis* and *Rana*. *Platymantis* is a speciose genus with the 27 described species endemic to the Philippines (IUCN, Conservation International, and NatureServe, 2004). Three species (Fig. 3A-C) were recorded from the study area. It is interesting to note that one species of *Platymantis* remains to be undescribed and suspected to be potentially new to science. Dr. Arvin Diesmos and Dr. Rafe Brown suggested that it be given the name *Platymantis* cf. *mimulus* (Fig. 3C) because it is very much similar to *Platymanis mimulus* until such time that further confirmation would be available to support the claim that this is a new species. *Platymanis mimulus* was first recorded from Mts. Banahao, Maquiling, and San Cristobal and the extent of its distribution in Luzon is yet to be known.

The genus *Rana* was represented by two species, one introduced species - *Rana erythraea* (Fig. 3D) and one Luzon endemic - *Rana similis* (Fig. 3E). This was previously known as a subspecies, *Rana signata similis*, which formed part of the *Rana signata* complex (which included all subspecies of *Rana signata*) of SE Asian stream frogs. Based from phylogenetic studies done by Brown and Guttman (2002) this is now considered to be a full species. *Fejeryarva vittigera* (Fig. 2B) was treated by Inger (1954) as a Philippine subspecies (*Rana limnocharis vittigera*) vicariating with the mainland Asiatic nominate subspecies (*R. limnocharis limnocharis*) but now it is also recognized as distinct species. Two species of fanged frogs, *Limnonectes macrocephalus* (Fig. 2D) and *L. woodworthi* (Fig. 2E) are both Luzon endemics.

Family Rhacophoridae included the tree frogs *Rhacophorus pardalis* (Fig. 3G, 3H) and *Polypedates leucomystax* (Fig. 3F) while Family Microhylidae was represented by a single species, *Kaloula picta*.

The taxonomic distribution of anurans in the study area followed the typical pattern known from other regions of the country, that is, it showed a proportionately large number of species belonging to Family Ranidae (Brown and Alcala 1955, 1970, 1986; Alcala 1986; Ross and Lazell 1991; Ross and Gonzales 1992; Gaulke 1994; Brown et al. 1996; Alcala et al. 1997; Brown et al. 2000; Ferner et al. 2000; Diesmos et al. 2003).

The anuran assemblage in the study area exhibited a remarkably high degree of endemicity (57%). At least eight species are endemic to the Philippines and of these four are Luzon endemics. All species of genus *Platymantis* collected from the study area are Philippine endemics including the undescribed species *Platymantis* cf. *mimulus*. Six of the eight Philippine endemics inhabited the riverine forest and the forest areas. This high endemicity and species richness (especially relative to the forest obligates) is probably correlated with the availability of different microhabitat types, relatively constant environmental conditions, high humidity, rapid decomposition (as evidenced by the presence of a wide variety of fungi and thick humus) resulting in high turnover of nutrients and availability of food resources.

Notes on biogeography

Though sampling effort was relatively equal across selected elevational gradient, the information on the anuran elevational distribution of MPPMNGPL is far from complete. Distributional data from more than 170 masl to less than 300 masl are still lacking. The following section presents a brief commentary on the biogeographic significance of this vertebrate group only based from available data.

Anurans were recorded in elevations from as low as 40 masl to more than 600 masl (Table 1). *B. marinus, H. chinensis*, and *R. erythraea* were the three introduced species recorded from the study area. The status and distribution of these alien invasive species were studied by Diesmos et al. (2006) and presently regarded *B. marinus* as the most widely distributed alien invasive species in the Philippines. Here, these species were recorded from 40-

170 masl but it was too soon to conclude that they have not reached elevation higher than 170 masl but they were not recorded from elevations higher than 300 masl. This could indicate that they are still not a threat to our native species at higher elevation.

Altitudinal distribution followed a common trend (Figure 4) as observed in other herpetofaunal assemblages in that as altitude increases species richness decreases (Custodio 1986, Diesmos 1998, Diesmos et al. 2003). Species richness was generally highest at lower elevation (40-170 masl) since most anuran species were congregated around streams (*L. macrocephalus*, *O. laevis*, *R. erythraea*, *F. limnocharis*, and *P. leucomystax*) and rice paddies (*B. marinus*, *H. chinensis*, *O. laevis*, *R. erythraea*, *F. limnocharis*, and *P. leucomystax*). Most of these exotic species usually occurred at lower elevations and preferred human-modified habitats. Most of the endemic species, however were recorded from higher elevations. *P. corrugatus*, *P.* cf. *mimulus*, *R. similis* and *L. woodworthi* occupied the broadest elevational range for the endemic species. It is also interesting to note that *P.* cf. *mimulus* also held the highest record in elevation (up to 620 masl). The success of these endemic species in occupying a broad elevational range may be attributed to their unique reproductive strategies and availability of breeding sites (Alcala 1986, Alcala and Brown 1998, Diesmos et al. 2003). *L. woodworthi* and *R. similis* were presumed to be found along the entire length of the mountain stream primarily because it was a very good breeding site for these aquatic species. *Platymantis* spp., however, do not require aquatic environments since they are known to undergo direct terrestrial development (Alcala 1962, Alcala 1986, Alcala and Brown 1982, 1998). Eggs are deposited on moist ground or in moist to wet arboreal situations where they develop directly into froglets, skipping the free-living tadpole stage. Being direct developers, these frogs do not require bodies of water to reproduce thus they are able to thrive in forest areas which are inhabitable to many species of frogs that are very dependent on water.

Ecology and natural history

The data show that majority (43%) of the anurans of MPPMNGPL are forest-restricted species while the remainder of the species are found in agricultural plantations and open, built up areas including three tolerant species, *K. picta*, *O. laevis*, and *P. leucomystax* (Table 1). Of the eight endemic species, six (75%) occurred in the riverine forest and forest habitat. All species of *Platymantis* were restricted to the forest area (including riverine forest) again for the reason that they are direct developers and can thrive on terrestrial habitats.

Forest-dwelling species were found to have more complex microhabitat requirements than nonforest-dwelling anurans. Eight (8) microhabitat types

(Table 2) were identified and a large proportion of anurans occurred in only two microhabitats which were bodies of water and forest floor litter. The anuran assemblage that dominated bodies of water included *L. woodworthi*, *O. laevis*, and *R. similis*. *Platymantis* spp. were found in a variety of microhabitat types including tree buttresses, shrubs, and crevices of fallen log but were mostly found in the forest floor litter.

Four microhabitats are known to have important functions in the life history of amphibians: diurnal shelter, calling site, breeding site, and oviposition site (Crump 1982, Heatwole 1982, Diesmos 1998). Microhabitats where nocturnal species retreat into during daytime are called diurnal shelters. They protect anurans from predation and dessication. Microhabitats where male frogs call and mate with females are known as calling and breeding sites. Egg-laying and deposition take place in oviposition sites. The forest floor litter appeared to be the most important diurnal shelter for all species of *Platymantis* while shrubs and crevices in fallen logs appeared to be calling and breeding sites of *Platymantis* cf. *mimulus*. Ranid forest frogs and most individuals of *L. woodworthi* hid under rocks in streams. Some individuals of this species probably hid under rotting leaves, leaf litter on stream banks, or dense undergrowth along the stream bank. One individual, however, was found on the forest floor litter (about 345 masl) far from the stream area.

The diurnal shelter of rhacophorids appeared to be shrubs growing along streams. *P. leucomystax*, being semi-arboreal, also occurred in the stream bank or very near bodies of water. One individual, however, was found inside a bamboo within the forest far from the stream area. All individuals of *R. pardalis* observed were found on shrubs growing along the stream at about 370 masl.

Most ranids have a generalized reproductive mode wherein they deposit eggs directly in water and have an aquatic developmental stage. Rhacophorid and platymantine frogs have specialized modes since they are totally independent of standing water (Crump 1982). Platymantines deposit terrestrial eggs that undergo direct development while rhacophorids lay eggs within foam nests. Several foam nests were seen during the collection. One was seen in a rice field near an irrigation path. This was believed to be from *P. leucomystax* since this species was present in this area. Other foam nests were seen attached to the leaves of a fern, shrubs growing near bodies of water and rocks in the riverine forest and appeared to be the oviposition sites for these rhacophorids.

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RECOMMENDATIONS

Herpetological collections that have been made were restricted to a small portion of the protected area leaving most parts unstudied. I strongly believe that additional species will be added to the herpetofauna of MPPMNGPL provided that more intensive field surveys are conducted especially in the unexplored areas. This is very important to provide good information to further our knowledge of the diversity, ecology, and biogeography of the herpetofauna of Luzon Island. Further knowledge is also of vital importance in generating more appropriate management decisions for the conservation of the only protected area in the province of Cavite.

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Table 1. Amphibian fauna of MPPMNGPL and immediate vicinities. Taxa in boldface are Philippine endemics, with "*" are Luzon endemics, and "+" are introduced species. Habitat: F = forest, R = riverine forest, A = agricultural, and O = open, built up areas; (+) indicates presence and (-) absence of species.

Taxa	Elevation (masl)	Habitat type A	O	R	F
BUFONIDAE					
+*Bufo marinus* (Linnaeus, 1758)	40 - 170	+	+	-	-
MICROHYLIDAE					
Kaloula picta (Duméril and Bibron, 1841)	40 - 300	+	+	-	+
RANIDAE					
Fejervarya vittigera (Weigman, 1835)	40 - 170	+	+	-	-
+*Hoplobatrachus chinensis* (Osbeck, 1765)	40	+	+	-	-
**Limnonectes macrocephalus* (Inger, 1954	40 - 170	+	-	-	-
**Limnonectes woodworthi* (Taylor, 1923)	300-400	-	-	+	+
Occidozyga laevis (Günther, 1859)	40 - 395	+	-	+	-
Platymantis corrugatus (Duméril, 1853)	300-400	-	-	-	+
Platymantis dorsalis (Duméril, 1853)	300-400	-	-	-	+
**Platymantis* cf. *mimulus* Brown, Alcala & Diesmos, 1997	250 -620	-	-	+	+
+*Rana erythraea* (Schlegel, 1837)	40 - 170	+	+	-	-
**Rana similis* (Günther, 1873)	300-400	-	-	+	-
RHACOPHORIDAE					
Polypedates leucomystax (Gravenhorst, 1829)	40 - 400	+	+	+	+
Rhacophorus pardalis (Günther, 1858)	350	-	-	+	-

Table 2. Microhabitat distribution patterns of forest frogs in the study area. Samples and degree of occurrence of species per microhabitat type (expressed in percentage, in parenthesis) are given.

		MICROHABITAT TYPES			
SPECIES	**Total Sample**	**Bodies of water (stream)**	**Dry beds of stream**	**Forest floor little**	**Tree Buttress**
Occidozyga laevis	41	41(100)			
Platymantis corrugatus	12			12(100)	
Platymantis dorsalis	4			2(50)	1(25)
Platymantis cf. *mimulus*	28			20(71)	1(4)
Rana similis	242	242(100)			
Limnonectes woodworthi	50	29(58)	20(40)	1(2)	
Polypedates leucomystax	11		3(27)		
Rhacophorus pardalis	10				

		MICROHABITAT TYPES			
SPECIES	**Total Sample**	**Inside bamboo**	**Shrubs growing along stream**	**Shrubs growing in forest**	**Inside crevices of fallen log**
Occidozyga laevis	41				
Platymantis corrugatus	12				
Platymantis dorsalis	4			1(25)	
Platymantis cf. *mimulus*	28			6(21)	1(4)
Rana similis	242				
Limnonectes woodworthi	50				
Polypedates leucomystax	11	1(9)	7(64)		
Rhacophorus pardalis	10		10(100)		

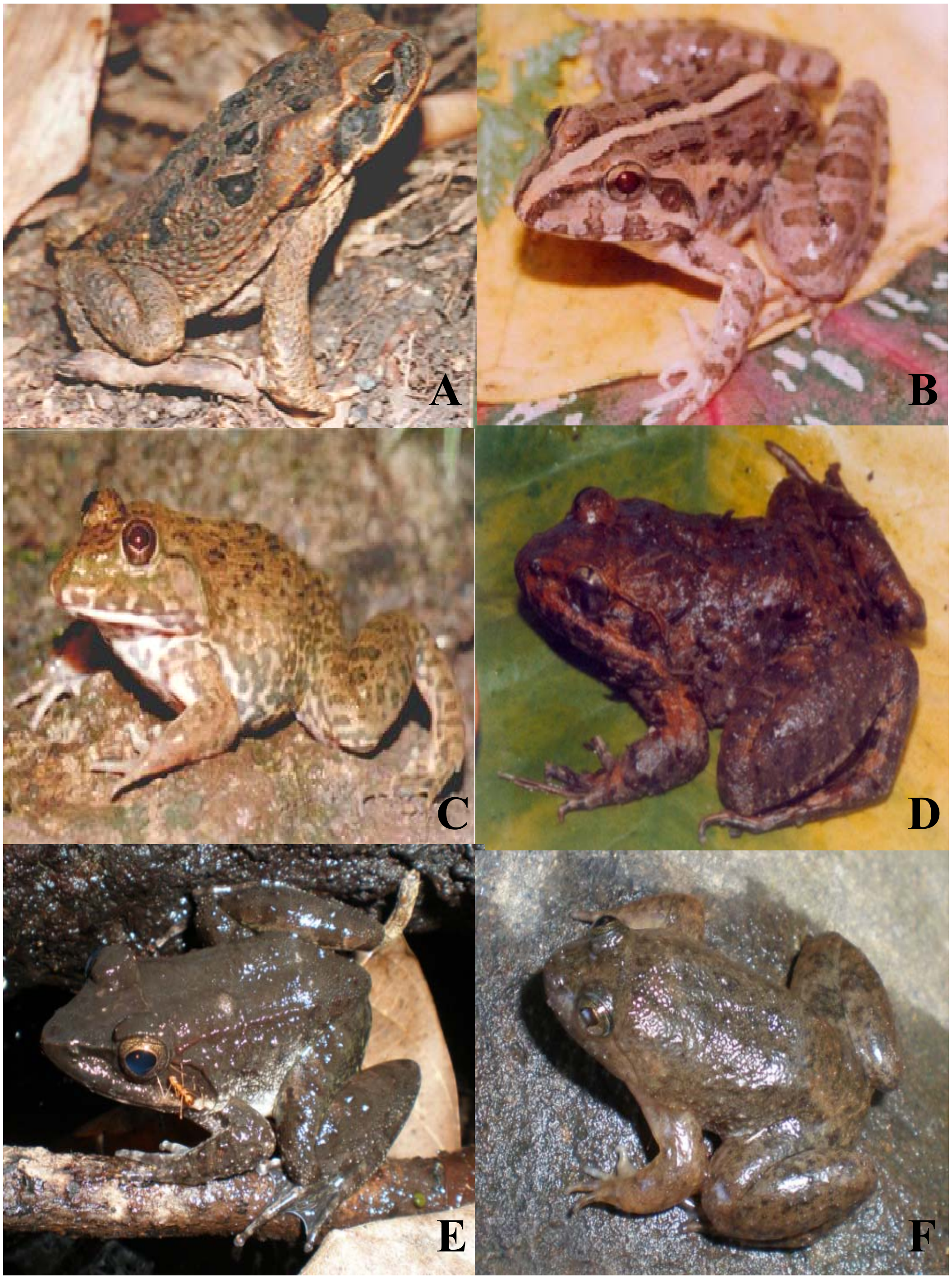

Figure 2. Anurans recorded from the study area. Bufonidae includes *Bufo marinus* (A) and Ranidae includes *Fejervarya vittigera* (B), *Hoplobatrachus rugulosus* (C), *Limnonectes macrocephalus* (D), *L. woodworthi* (E), and *Occydozyga laevis* (F). (Photos by R. Causaren).

Figure 3. Anurans recorded from the study area (continued). Ranidae includes *Platymantis corrugatus* (A), *P. dorsalis* (B), *P.* cf. *mimulus* (C), *Rana erythraea* (D), and *R. similis* (E). Rhacophoridae includes *Polypedates leucomystax* (F). *Rhacophorus pardalis* male (G) and female (H). (Photos by R. Causaren).

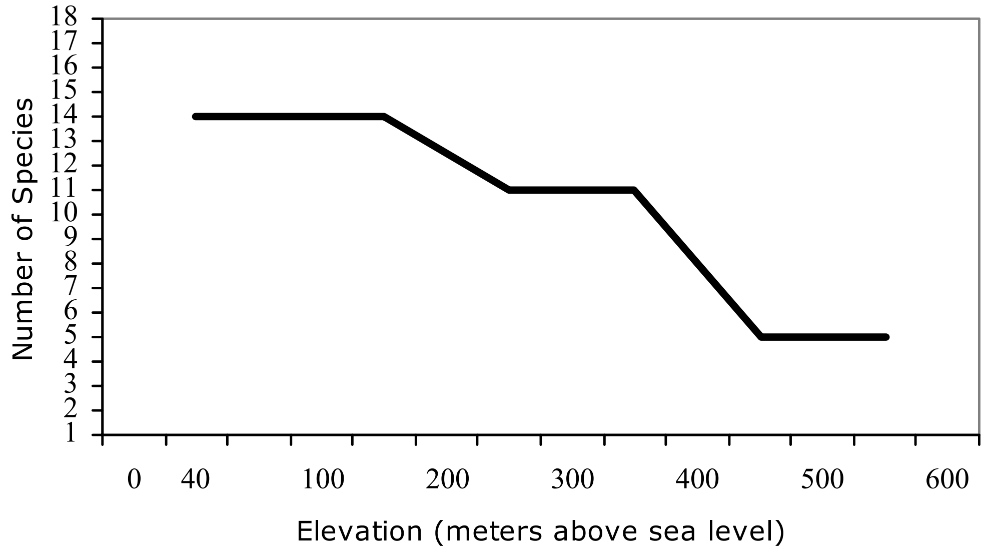

Figure 4. Species-elevation curve of the anurans of MPPMNGPL and immediate vicinities.