International Research Journal of Biological Sciences _____ ISSN 2278-3202
Vol. **2(10),** 51-63, October **(2013)** *Int. Res. J. Biological Sci.*

Frogs and their Microhabitat Preferences in the Agricultural and Secondary Forest areas in the Vicinity of Mt. Kalatungan Mountain, Bukidnon, Philippines

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Available online at: www.isca.in, www.isca.me
Received 17th July 2013, revised 25th July 2013, accepted 4th September 2013

Abstract

An inventory of amphibians was conducted in the lower montane forest and immediate vicinity of Mt. Kalatungan, Bukidnon. The study was conducted in 2 sampling sites of the mountain. Site 1 was an agricultural area, located at 1100-1200 masl while sampling site 2 was a secondary forest, located at 1300-1600 masl. Using visual encounter survey, a total of 94 individuals belonging to 15 different species was collected. A total of 60% of the amphibians observed were Philippine endemics; six species were under Vulnerable Category in the 2004 IUCN Red List Threatened Species; one species was listed under the near threatened category; and one species was listed under the endangered category. Species richness was moderate (H'=2.145) and evenness was relatively higher (E=0.792) in the lower montane forest and vicinity of Mt. Kalatungan. Most of the recorded amphibians were observed to inhabit type IV microhabitat (substrate level or the ground litter microhabitat) suggesting that the area still has considerable thermal and hydrologic conditions for the survival of amphibians and/or it also suggests good water quality and watershed condition. There are however the existence of many threats such as deforestation, illegal logging and mining, clearing of the forest for agriculture, hunting and overexploitation of forest resources by the communities and increasing human settlements in the area. Protection of the remaining habitat and promotion of conservation programs in Mt. Kalatungan is needed to minimize the decline of amphibian population in the area.

Keywords: Microhabitat, vulnerability, endangered, watershed.

Introduction

Mt. Kalatungan Range Natural Park covers an area of 21, 248 hectares. It was proclaimed in July 5, 2000, under Proc. 305. It is located in the central section of Bukidnon Province within the Mindanao Central Cordillera. It is bounded on the northwest by the Municipality of Talakag, on the northeast by the Municipality of Valencia, on the southeast by the Municipality of Maramag, and on the southwest by the Municipality of Pangantucan. The land within the boundary of Mt. Kalatungan Range has a declared timberland area of 21, 301 hectares; identical vegetation cover proclaimed under P.D. 127 has 11, 371 hectares; Burned Area 100 hectares; and "slash-and-burn" or "Kaingin" Area totalled 50 hectares. It is located at the coordinates of 124° 40' to 124° 57' longitude and 7° 53' to 8° 02' latitude. The entire land is government owned. The government has established various watershed and reforestation projects located on the northern, southern and western side of the range. Ethnic communities, barangays, and sitios dependent on farming agricultural crops occupy other areas[1]. The whole area of the Kalatungan Range falls under the Type III climate and is characterized as having a short dry season lasting only from 1 to 3 months and not pronounced maximum rain period as described by the Modified Corona's Classification. Average temperature is 24.7°C. Most of the areas receive the highest amount of rainfall during the month of June while March is the driest month. The relative humidity varies from 71% during the month of May to 86% during the month of September. The area is virtually cloud-covered throughout the year[1].

The current status of Mt. Kalatungan in the mountain range is considered extremely highly critical. Deforestation and habitat destruction and serious inadequacies in the existing environmental protection measures and protected areas network affecting biodiversity conservation[2] are observable in the area. One the groups vulnerable to habitat changes is the amphibian considered as good indicators of habitat quality due to its dual life mode and limited dispersal capabilities[3]. Over 70% of the 114 known amphibian species in the Philippines are endemic[4]. If the present rate of deforestation in the Philippines including the Mt. Kalatungan range continues, most endemics face a high probability of extinction in the near future[5]. Since nearly all-major international conservation organization regarded the Philippines as one of the top global priorities for conservation due to the enormous biological diversity in the flora and fauna of the archipelago and extraordinarily high rate of "endemicity" within the biota and high habitat diversity, this study was conducted. Considering however some issues of security, the study was limited to the agricultural and secondary forest areas of one of the mountains in the range, Mt. Kalatungan.

Mount Kalatungan is a stratovolcano or a potentially active volcano which is one of the several high elevation peaks in the Kalatungan Mountain Range in Bukidnon province on the island of Mindanao (figure 1). It is considered the sixth highest mountain in the Philippines, with an elevation of 2,824 metres asl. At present there are the existence of many threats to the mountain as there are existing encroachment of the mountain park by human settlements. To be able to come up with measures for the protection and conservation of the remaining protected areas of the mountain, the study was conducted on one group of animal species that are good indicators of environmental quality, the amphibians. To achieve this major objective, the study assessed the occurrence of amphibian species and their microhabitat preferences. Included are the i. identification of the observed species; ii. determine and compare the relative abundance, species diversity and evenness between habitat types; iii. describe the features of microhabitats or areas that appeared to be important to amphibians; iv. identify the current and future threats to amphibians of Mt. Kalatungan and present some measures for their protection and conservation.

Material and Methods

Sample collections were done in the lower montane forest and immediate vicinity of the mountain and in the agricultural area and secondary forest near the villages of Sitio San Guinto, Bacusanon, Pangantucan of Bukidnon, Philippines. Descriptions of the habitats were based on the Habitat Description Form (HDF)[6].

Sampling site was chosen according to vegetation type observed in the area in an elevation within 1000-15000 masl. The site was then divided into four categories according to microhabitat types[7] namely: Type I: Arboreal microhabitats as characterized by clumps of moss and other bryophytes, epiphytic plants such as orchids, ferns, vine/climbers present on trees or above the ground; Type II: Leaf-axils as characterized by water-filled axils of Araceae, Pandanaceae, Musaceae and Cyatheaceae (tree ferns); Type III: Vertical stratum as characterized by tree holes and similar crevices in the main branches approximately along the middle stratum of the forest. This includes tree bark and buttresses (1-10 m high), and Type IV: Substrate level or ground litter as characterized by rocks, tree stumps, burrows, fallen logs or tree fall and leaf litter (figure 2).

Figure - 1
The study site (a) Philippine map, (b) Mindanao map (c,d) Mt. Kalatungan Range Park.

Figure -2
Selected sites of frog collection (a) secondary forest; (b) pond; (c) (d) Sarukadang Stream

Relative humidity in the sampling areas was determined using the Sling psychrometer. Before using, the wick was thoroughly saturated with water. The end cap was removed and immersed psychrometer body up to the mercury reservoir on the thermometers until wick was thoroughly wetted. Then, fill end cap with water and replaced; tightened just enough to prevent leakage. And, when used, the wick was wet and covered the mercury reservoir on the bulb thermometer and the other (dry bulb) was dried. Then, the tube was pulled clear of body so body can swivel. Holding the tube, whirled body for five minutes until the temperature stabilized. Immediately read the wet bulb thermometer and the dry bulb thermometer. Then wet and dry bulb temperatures were set opposite each other on side rule calculator type scales and the percent relative humidity was read.

The rain fall distribution of the area was determined using the secondary information obtained from the DENR-PAWB that provides the amount and schedule of rainfall in the sampling area.

For the soil pH, a small amount of soil sample was obtained in each of the sampling areas. The soil sample was placed in a transparent plastic bag and was bought in the laboratory for soil pH determination. Twenty grams of soil sample was weighed using analytical balance, and then placed in a beaker and forty milliliters of distilled water was added into it. Stirred until all the soil samples dissolved. Allow to stand for thirty minutes, and then using pH tester 30, the pH of the sampling sites was determined and recorded in the field notebook. In doing the ph measurements, the button tester was switched on, then the electrode was dipped for about 2-3 centimeters into a test solution (the supernatant of the dissolved soil samples), stirred until the reading stabilized.

Collections of amphibians were made in the early morning 6:00-9:00 a.m. and late afternoon 7:00-10:00 p.m. The Visual Encounter Survey was used in the study to conduct searches in high potential areas throughout the sampling sites, such as around rocks, under large wood debris, body of water (e.g. streams and rivers), dead and live vegetation stands (along linear features), during sunny and after the rain (figure 3).

Figure - 3

Microhabitats of observed amphibian species (a) stream at 1208masl, microhabitat of *Fejervarya cancrivora* and *Hylarana grandocula*; (b) *Alocasia sp*. microhabitat of *Staurois natator*; (c) decomposing fallen log, microhabitat of *Kalophrhynus pleurostigma* and *Megophrys stejnegeri*; (d) lef litters at 1358masl, microhabitat *Megophrys stejnegeri* and *Polypedates leucomystax*, *Ansonia mcgregori* and *A. muelleri*; (e) Sarukhadang stream at 1356masl, microhabitat of *Occidozyga laevis*; (f) tree epiphytes at 1357masl, microhabitat of *Philautus acutirostris*; (g) *Cyathea contaminans* at 1367masl. microhabitat of *Philautus acutirostris*; (h) *Asplenium nidus* at 1400-1500masl, microhabitat of *Philautus sp*.; (i) *Liptocarpus sp*. buttress at 1400masl, microhabitat of *Megophrys stejnegeri*; and (not shown) are bananas species at 1400-1500masl where *Philautus acutirostris* were observed

Specimens were captured directly by bare hands. Then, they were placed in plastic bag separately and labeled taking note of the microhabitat, date and time of collection. Live samples were brought in the field station for identification.

After being captured, the specimens were processed immediately in the field station and tranquilized with denatured alcohol by injecting a small amount in the vent of each specimen. Then, using the vernier caliper, the vital body parts were measured for obtaining the morphometrics of each specimen for identification. These included the snout-vent length (SVL), head width (HW), head length (HL), tympanum width (TW), Internarial Width (InW), tympanum diameter (TD), Interorbital width (IoW), tibia length (TL), and toe length (TL). This followed by taking photograph of each specimen.

Individuals that are directly identified in the field were marked with permanent markers after they were identified and released back in the field, and those that were not directly identified were taken as vouchers for taxonomic studies. These samples were fixed in 10% formaldehyde and were stored in denatures alcohol for permanent preservation.

Relative abundance was used as a way of measuring environmental health[8] and was obtained by dividing the toyal number of individuals by the total abundance of all species combined[9]. Diversity index was determined using the Shannon Weaver Index of Diversity. Here, species diversity values less than one i. represent low diversity[10]. Evenness (E) was also obtained by measuring how similar the abundances of different species/categories are in a community which may ranged from zero to one. When evenness was close to zero, it indicates that most of the individuals belong to one or a few

species/categories. When the evenness is close to one, it indicates that each species/categories consists of the same number of individuals[10]. Species richness was obtained by determining the total number of different organisms present in the area.

Results and Discussion

The first sampling site was located at 1208-1300 masl; N 7.90658; E 124.72382. It has an agro-ecosystem vegetation type with a mountainous slope. The trees found in the area were red lauan (*Shorea negronensis*), white lauan (*Shorea contoria*), guava (*Psidium guajava*) and coconut (*Cocos nucifera*). The dominant vegetation found in the area was cogon (*Cylindrica imperata*), bogang (*Saccharum spontaneum*), tree ferns (*Cyathea contaminans*), ground ferns (*Musa sp*., wild sunflower (*Tithonia sp*.), bamboo (*Bambusa sp*.), *Eucalyptus sp*., makahiya (*Mimosa pudica*), castor bean (*Ricinus communis*), badiang (*Colocasia sp*.), duranta (*Duranta erecta*), lemon grass (*Andropogan s*p.), citrus (*Citrus lemon*), coffee (*Coffea arabica*). Exposed rocks in the area were about 2-4% along the stream and the road. The distance to anthropogenic clearing is within the expanding human population inhabiting the area. On site disturbances identified were human settlement expansion, kaingin, new roads and man-made trails.

The second sampling site was observed to be an agricultural area and secondary forest, located at 1300-1600masl; 7.92474N; 124.73241E. The topography is mountainous to undulating. The vegetation were composed of tanga trees (*Pygeum preslii*) and ulayan (*Lithocarpus sp*.) common grasses or sedges such as cogon (*Cylindrica imperata*) and bogang (*Saccharum spontaneum*). Most common epiphytes were lichens, wild orchids, and mosses. Most abundant understory plants were tree ferns (*Cyathea contaminans*), and plants only known locally as anggoka, titii, katbutig-butig, and hinagdong (*trama orientalis*). Ground ferns were the most abundant ground cover. Pandanus density in the area is widely distributed over the sampling site. *Ficus* density was less than 5%. Fruit trees were rarely found. *Musa* species density was also rare in the area. Pitcher plant was almost absent in the area and moss density was rarely found in the trees and on fallen logs.

Leaf litter cover in the area reaches 5 layers and humus cover depth is 2-6 cm. stream is found within the vicinity of the secondary forest, with a distance of 4-6 m away from the camp. Site disturbances in the area were mostly man- made (e.g. trail, kaingin, and camp). Distance to anthropogenic clearing is 5-7 m away from the camp.

Frog species: A total of 15 species belonging to five families of frogs was recorded in the lower montane forest sampling sites and immediate vicinity of Mt. Kalatungan (figure 4). Six species were included in the list of Vulnerable to extinction in the wild category. These are *Ansonia muelleri*, *A. mcgregori, Megophrys stejnegeri, Philautus acutirostris, Philautus* cf. *poecilus* and *P. worcesteri*; One Near Threatened species – *Limnonectes magnus*; and one Endangered species, *Philautus surrufus*. The other species are included in the category of Least Concern, namely: *Occidozyga laevis, Kalophrynus pleurostigma, Pelophryne brevipes, Polypedates leucomystax, Hylarana grandocula, Fejervarya cancrivora,* and *Staurois natator*. Moreover, a total of nine endemic species were identified in the lower montane forest.

Ansonia mcgregori Inger, 1960: Synonym: *Bufo mcgregori* Tylor, 1962[a]: This species is also known as the Mcgregor's stream toad and were reported to be distributed in Western Mindanao particularly in Zamboanga Provinces. In Mt. Kalatungan, *A. mcgregori* was distributed along the elevation of 1300-1600 masl, particularly along the Sarukadang and Muntian stream. The species was commonly found above rocks covered with mosses attached to it, on rock crevices; on ground litters along and near the streams, and along the trail.

Mcgregor's stream toad has an average snout-vent length of 26mm; HL = 6 mm; HW = 7; TW = 3mm; ED = 3mm; InW = 3mm; IoW = 3mm; TL = 13 mm; 4th toe length = 10 mm. it has a remarkable dark green to dark winding lines dorsally and laterally running from the snout to vent; tongue not adherent toothless upper jaw; fingers without webbing or less web; no parotid glands.

Ansonia muelleri, Inger, 1954: Synonym: *Bufo muelleri* Boulenger, 1887: *Ansonia muelleri* is reported to be found only in Mindanao and Dinagat Islands in the Philippines, thus it is referred as Mindanao endemic species[11].

Ansonia muelleri has an average snout-vent length of 28 mm; HL = 9 mm; HW = 8; TW = 2 mm; ED = 3 mm; InW = 2 mm; IoW = 3 mm, TL = 13 mm; 4th toe length = 11 mm. it has a remarkable alternate dark brown straight lines running from the snout to vent; dark bands on its forelimbs and hind limbs prominent; more web toe except for the 4th toe.

In Mt. Kalatungan, it is observed to be very abundant, commonly found on rocks above the surface of running water to whom it mimics the small green plants (e.g. mosses) attached on rocks and on forest floor near the stream, predominantly in the second sampling site with an elevation of 1300-1500 masl particularly along the Sarukadand and Muntian streams. Also found on leaf axils of *Cyathea contaminans,* tree fern.

Kalophrynus pleurostigma, Tschudi, 1838: Synonym: *Kalophrynus minusculus* Iskandar, 1998: This species is widely distributed in the Philippines (Mindanao, Leyte, Maripipi, Bohol, and Camiguin Islands). It was also documented in Sundaland, Tenasserim-Malay Penensula, including the Low elevation forest in Western Java and on Western tip Sumatra, Indonesia[12].

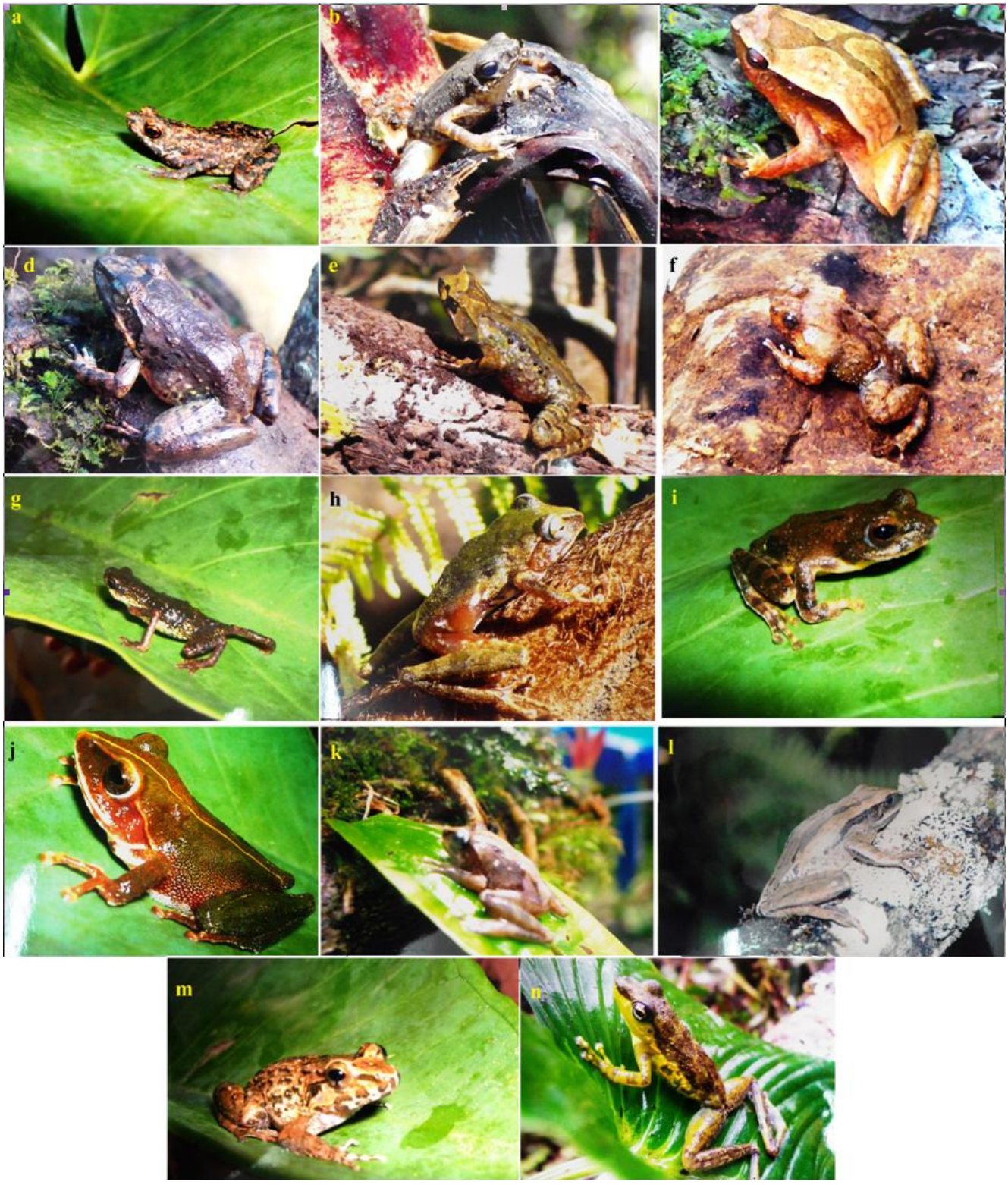

Figure - 4

Species of frogs (a) ***Ansonia mcgregori,*** **(b)** ***Ansonia muelleri*****, (c)** ***Kalophrynus pleurostigma,*** **(d)** ***Limnonectes magnus*****, (e)** ***Megophrys stejnegeri,*** **(f)** ***Occidozyga laevis,*** **(g)** ***Pelophryne brevipes,*** **(h-j)** ***Philautus acutirostris,*** **(k)** ***P. worcesteri,*** **(l) (*** ***Polypedates leucomystax*****), (m)** ***Hylarana cancrivora*** **(n)** ***Staurois natator*****. (Other species not shown were** ***Philautus*** **cf.** ***poecilus, Philautus surrufus, Pelopphryne brevipes, Rana grandocula,*** **and** ***Fejervarya cancrivora***

Kalophrynus pleurostigma has an average snout-vent length of 40 mm; HL = 12 mm; HW = 12; TW = 3 mm; ED = 4 mm; InW = 2mm; IoW = 5 mm; TL = 17 mm; 4th toe length = 4 mm. In Kalatungan, two colormorphs were observed, one yellow in color and the other one was reddish brown to nearly black. Both has two dark concentric circles near its groin; presence of brown bands on its forelimbs and hindlimbs; prominent tympanum; lateral folds running from snout to hindlimbs; webbed toes; and two brown stripes running both from the eyelid to its groin forming X- mark is present.

In Mt. Kalatungan, this species was found to have conspicuous black spot on the back near of each groin (absent in only few individuals). It is characterized with the granular thick skin. Fingers and toes are slightly swollen with rounded tips. In some individuals, there is a dark pattern on black consisting of two stripes, each running from eyelid to the opposite groin forming an X- mark[5].

The two colormorphs of the species were found on the forest floor one along the trail, and the other one near the cave. The trail is characterized by rapid decomposing leaf litters and ground ferns. On the other hand, the distance of the cave where it is found is about 10 m away. The area near the cave is characterized by bagon, ground ferns, *Alocasia sp.,* and trees.

Limnonectes (Limnonectes) magnus, Dubios, 1987: Synonyms: *Rana magna* Stejneger, 1910; *Rana (Rana) magna,* Boulenger, 1920; *Rana modesta magna,* Smith, 1927; *Rana macrodon magna,* Inger, 1954; *Rana magna magna,* Inger, 1958 *Rana (Euphlyctis) magna,* Dubois, 1981.

L. magnus has an average snout-vent length of 61 mm; HL = 17 mm; HW = 21; TW = 12 mm; ED = 6 mm; InW = 5 mm; IoW = 7 mm; TL = 31 mm; 4th toe length = 27 mm. it has a visible tympanum; dark bands on its forelimbs and hindlimbs. Laterally, it has light yellow spot near its groin; fold is present from snout to base of forelimbs; abdomen has smooth granular skin.

The species was locally referred to as the Mt. Apo Wart Frog. *L. magnus* is reported to be distributed in Mindanao and Basilan Is., Philippines. In Mt. Kalatungan, it was evenly distributed along the elevation of 1300-1600 masl of the lower end of Sarukadang stream. It was commonly found on rocks above flowing water during night and burrowing along the stream beds during daytime. The rocks it inhabited were covered with Bryophytes (e.g. mosses). The stream beds is slightly covered with scattered leaf litters about 3-5 layers. Some of these leaf litters are broad leaf under family Araceae, and inside the cave.

This species are commonly used as a food by the inhabitants of Mt. Kalatungan, particularly in Sitio Guinto, Bacusanon, Pangantucan, Bukidnon.

Megophrys stejnegeri, Iskander, 1998: Synonyms: *Megalophrys stejnegeri,* Taylor 1920; *Megophrys monticola stejnegeri,* Inger: *Megophrys stejnegeri* has an average snout-vent of 49 mm; HL = 15 mm; HW = 18; TW = 2 mm; ED = 5 mm; InW = 3 mm; IoW = 6 mm; TL = 18 mm; 4th toe length = 16 mm. some of this species are red-orange in color, and some have a combination of yellow and dark green. It has a pair of longitudinal fold on back is present; dark bands on forelimbs and hindlimbs is present; visible tympanum and a horn over its eyelid.

This species was commonly named Horned frog and is reported to be distributed only in Mindanao, Philippines. In Mt. Kalatungan it was found along the elevation 1300-1500 masl. In Mt Kalatungan, it is commonly found on the forest floor where leaf cover is relatively thick and in decomposing logs where Pteriodophytes and Bryophytes were copiously growing, and in buttress of *Lithocarpus sp.* Mostly, found at an elevation of 1300-1500 masl.

Occidozyga laevis, Dubois, 1981: Synonyms: *Oxyglossus laevis,* Gunther, 1858; *Phrynoglossus laevis,* Peters, 1867; *Oxyglossus martensii,* Boulenger, 1882; *Ooeidozyga laevis martensi,* Pope, 1931; *Occydozyga martensii,* Dubois, 1981; *Phrynoglossus martensii,* Dubois, 1987; *Oxyglossis laevis martensi,* Smith, 1916 *Phrynoglossus laevis martensi,* Smith.

Occidozyga laevis has an average snout-vent length of 20 mm: HL = 7 mm; HW = 8; TW = 2 mm; ED = 2mm; InW = 2 mm; IoW = 3 mm; TL = 11 mm; 4th toe length = 11 mm. a heavily muscled frog, short limbs, and fully web toes. Digits have circummarginal grooves. Lateral has a tiny protrusions; dark bands in forelimbs and hindlimbs. Its color varies from brown to grey.

This species is commonly referred to as the Common Puddle Frog and was reported to be distributed in Southeast Asia-Java, Sumatra, Sulawesi, Bal, Sumbabawa, Flores, Singapore, and Philippines. In Mt. Kalatungan it was distributed along the elevation of 1300-1600 masl.

Pelophryne brevipes, Barbour, 1938: Synonyms: *Hylapesia brevipes,* Peters, 1867: This species is distributed in Sudan islands, Malay Archipelago, and Mindanao Philippines. In Kalatungan it is only found at 1400-1500 masl.

Southeast Asian Toadlet or Zamboanga Flathead Toad in the Philippines is a non-endemic species, and uncommon; has an average snout-vent length of 22 mm; HL = 6 mm; HW = 6; TW = 2 mm; ED = 1 mm; InW = 2 mm; IoW = 3 mm; TL = 7 mm; 4th toe length = 6 mm. This is distinguished by the presence of hour glass marking on the back and a yellow or white stripe or row spots on upper lip from below eye to below tympanum.

The two species were both found at an elevation of 1400-1500 masl where it dwells in tungog. This area to where it was found is relatively humid, not regularly visited by people and low light penetration.

Philautus acutirostris: Synonym: *Ixalus acutirostris,* Peters, 1867; *Philautus basilanensis,* Taylor, 1922; *Philautus woodi,* Stejneger, 1905 *Rhacophorus (Philautus) acutirostris,* Ahl

The Philippine Bubble-nest Frog is a small *Philautus* species are distributed only in Basilan and in Mindanao Islands. In Kalatungan, it is found only at 1400-1600 masl.

Philautus acutirostris has an average snout-vent length of 24 mm; HL = 9 mm; HW = 8; TW = 1 mm; ED = 3 mm; InW = 1 mm; IoW = 3 mm; TL = 14 mm; 4^{th} toe length = 10 mm; with pointed snout. Fingers without webs, but toes are webbed; upper eyelids with papillae; usually two prominences between the eyes. It is endemic and uncommon.

In Kalatungan, this species is found at an elevational range of 1400-1500 masl. Its microhabitats were *Musa sapientum, Musa textiles, Asplenium nidus, Trema orientalis* and *Cyathea contaminans.* In *Musa sapientum,* this species was found hiding the leaf axil with water and moderately exposed to sunlight; species found in *M. textiles* is also hiding the leaf axil filled with water; and the species found on withering *C. contaminans* still in leaf axil, no water at all, but it has moist sediments. These areas are not regularly visited by the inhabitants near the forest.

Philautus worcesteri, Alcala and Brown, 1998: Synonym: *Cornufer worcesteri,* Stejneger, 1905; *Rhacophorus emembranatus,* Inger, 1954; *Philautus emembranatus,* Liem, 1970

Smooth-skinned Tree Frog, or Mindanao Bubble-nest Frog, *Philautusworcesteri*. This species is distributed in the Mountain ranges of Agusan del Norte, Davao, Misamis Occidental, and Zamboanga del Norte provinces, Mindanao Island, Philippines.

It has an average snout-vent length of 33 mm; HL = 11 mm; TW = 2 mm; ED = 4 mm; InW = 2 mm; IoW = 5 mm; TL = 6 mm; 4^{th} toe length = 4 mm. This species have round pointed snout or ending in a knob-like protrusion and tympanum covered with skin, an endemic and rare species in the Philippines.

Philautus poecilus: This species can be found to be distributed in Mindanao Islands, particularly in Bukidnon, Agusan del Norte, and Zamboanga Province, Mindanao, Philippines. In Mt. Kalatungan, *Philautus poecilus* was found at 1546 masl, particularly along the trail leaf litter near *Pandanus sp.*

Molted Tree Frog has an average snout-vent length of 38.8 mm; HL = 17.2 mm; HW = 3.8 mm; TW = 2.4 mm; ED = 402 mm; InW = 1.9 mm; IoW = 3.1 mm; TL = 21.0 mm. Dorsally, it has a yellow-orange vertical line running from its head to vent; laterally, it has a yellow-green bands; upper eyelid: yellow-orange; femur with three prominent dark bands, and along these bands are a single line can be observed from its vent to knee; both limbs (fore and hindlimbs) fully web with gelatinous pad; tympanic membrane visible; when viewed ventrally, dark spots can be observed to be evenly distributed over its body.

Philautus surrufus: This species can be found distributed in Mindanao Islands, particularly in Bukidnon, and Misamis Occidental, Mindanao, Philippines. In Mt. Kalatungan, *Philautus surrufus* was found at 1546 masl, particularly in the tree ferns, *Cyathea sp.* with height of approximately less than 1 m above ground.

Molted Tree Frog has an average snout-vent length of 20.7 mm; HL = 7.5 mm; HW = 6.3 mm; TW = 1.3 mm; ED = 2.9 mm; InW = 0.6 mm; IoW = 2.4 mm; TL = 12.0 mm. Dorsally, it has a wart like protrusions; laterally, it has a white spot evenly distributed; hind and forelimbs not web, but with pad; femur has a single oblique line red-orange in color; dark bands can also be observed in the fibula and tibia; tympanic membrane visible.

Polypedates leucomystax*,* Gravenhorst, 1892: Synonyms: *Hyla sexvirgata,* Gravenhorst, 1829; *Rahacophorus wirzi*; Forcart, 1946; *Hyla leucomystax,* Gravenhorst, 1829; *Rhacophorus quadrilineatus,* Inger, 1954; *Polypedates leucomystax,* Tschudi, 1838; *Rhacophorus himalayanus,* Ahl, 1931.

This species was geographically distributed in Lesser Sundas; Northeastern Montane Region; Philippine Islands; Southeast Asian Lowlands; Southern Himalayan Flanks; Sulawesi; Sundaland; Tenasserim-Malay Peninsula; Thai-Lao Dry Plateau. In Kalatungan, it is found along the elevation of 1300-1600 masl.

Common Tree Frog has an average snout-vent length of 54 mm; HL = 17 mm; HW = 17; TW = 4 mm; ED = 6 mm; InW = 3 mm; IoW = 7 mm; TL = 27 mm; 4^{th} toe length = 15 mm. This is characterized by a rudimentary web on fingers, but extensively webbing in toes. Toe pad is smaller than the finger. Smooth dorsal surface, with four distinct longitudinal lines that are sometimes broken. Skin of head partially ossified with skull. A non-endemic and common.

In Mt Kalatungan, some species are found in grasslands near the kaingin; on trees (*Lithorcarpus sp.*); and on decaying fallen logs. This grassland has a rolling slope and surrounded by cultivated lands, and 120-150 m away from the stream in its foot. The area where it was found is near the temporary pond intended for carabaos. *Lithocarpus sp.* was relatively abundant and evenly distributed in the area, and it was also observed as one of the favored plant species by epiphytes, especially lichens. Moreover, decaying fallen logs is more abundant in the area, with growing pteriodophytes and bryophytes on it.

Fejervarya cancrivora*,* Gravenhorst, 1829: Synonyms: *Rana moodiei*, *Taylor*, 1920; *Fejervarya cancrivora,* Gravenhorst, 1829; *Rana tigerina angustopalmata,* Barbour, 1912; *Rana tigerina var. cancrivora,* Boulenger, 1918; *Rana tigerina var. angustopalmata,* Kampen, 1907

This is distributed in Bohol, Mindanao, and Bailan. In Kalatungan, it is only found at 1208-1300 masl.

Asian Brackish Water Frog or Java Wart Frog has an average snout-vent length of 39 mm; HL = 15 mm; HW = 14 mm; TW = 3 mm; ED = 4 mm; InW = 3 mm; IoW = 3 mm; TL = 19 mm; 4th toe length = 18 mm. Body is stocky and heavy muscled. Hindlimbs are moderately short. Dorsal skin has irregular folds. Webs of toes are deeply excised between toes. Tips of digits are not dilated. A distinct fringe of skin is present on outer side of the 5th toe and metatarsal. An endemic and common species.

This species were found above rocks and in forest floor at 1000-1200 masl elevations

Hylarana grandocula*,* Inger and Tan, 1996: Synonyms: *Rana philippinessis,* Taylor, 1920; *Rana yakani,* Taylor, 1922: This can be also be found in Bohol, Basilan, and in Mindanao. In Kalatungan, it is found only along the elevation of 1200-1356 masl.

Big-eyed Frog, *R. grandocula* has an average snout-vent length of 47 mm; HL = 17 mm; HW = 11 mm; TW = 4 mm; ED = 6 mm; InW = 3 mm; IoW = 4 mm; TL = 23 mm; 4th toe length + 20 mm. it is characterized by narrow dorso-lateral light line (less than 1 mm) with indistinctive median border. Its mid-dorsum is usually light with irregular mooting of darker pigment. Light line on upper eyelid and canthus rostralis is also indistinctive. Most of the individuals have shagreened skin, although the full range from smooth to coarsely granular skin is found[13].

Staurois natator: Synonym: *Staurus guttatus,* Cope, 1865; *Ixalus granulates,* Boettger, 1888; *Polypedates guttatus,* Gunther, 1872; *Rana natatrix,* Boulenger, 1882; *Rhacophorus granulosus,* Ahl, 1927; *Rana guttatus,* Smith, 1931

This species is distributed in Borneo, Bohol, Palawan, Busuanga, Mindanao, and Leyte. In Kalatungan, this can be found at from 1300-1600 masl along the streams.

The Rock Frog, or Mindanao Splash Frog, *Staurois natator* has an average snout-vent length of 33 mm; HL = 12 mm; HW = 9 mm; TW = 2 mm; ED = 4 mm; InW = 3 mm; IoW = 3 mm; TL = 21 mm; 4th toe length = 16 mm. It is characterized of having relatively slender body and long slender legs, with skin above granular. Fingers and toes have broadly dilated tips with both transverse and circummarginal grooves. Toes are completely webbed[5].

At night they are usually found on leaves plants, *Alocasia sp.* under Family Araceae. This plant species are broad leaf that frogs able to stay for short time waiting for its prey.

Biodiversity: The status of the different species identified in Mt. Kalatungan based on previous reports is presented in table 2. Of the 15 species identified, 8 were Mindanao endemic, 1 endangered, 1 near-threatened and 6 vulnerable[5].

A total of 94 individuals were recorded an all sites (table 3). The highest abundance and diversity was recorded in the secondary forest, where 91 frogs were captured. *Ansonia muelleri* (38.46%) was the most abundant species in the secondary forest. This accounted difference is probably due to the leaf litter cover, herbaceous vegetation, and the presence of water (e.g. streams) in the area that is characterized by temporary ponds and streams. According to Nuzzo and Mierzwa[15], during late summer, temporary ponds support more amphibians, especially toads than in shallow ponds that dried early in the summer. Moreover, sites that were located near the other ponds also support toads significantly. The lowest was recorded in the agricultural area, where only 3 amphibians were captured during the study period.

Table-2
Frogs Present in the lower montane forest and vicinity of Mt. Kalatungan with corresponding residency and conservation status

Family	Species	Residency[5]	Conservation Status[14]
BUFONIDAE	*Ansonia mcgregori*	Mindanao Endemic	Vulnerable
	Ansonia muelleri	Mindanao Endemic	Vulnerable
	Pelophryne brevipes	Non-endemic	Least Concern
MEGOPHRYIDAE	*Megophrys stejnegeri*	Mindanao Endemic	Vulnerable
MICROHYALIDAE	*Kalophrynus pleurostigma*	Non-endemic	Least Concern
RHACOPHORIDAE	*Polypedates leucomystax*	Non-endemic	Least Concern
	Philautus acutirostris	Mindanao Endemic	Vulnerable
	Philautus cf. poecilus	Mindanao Endemic	Vulnerable
	Philautus surrufus	Mindanao Endemic	Endangered
	Philautus worcesteri	Mindanao Endemic	Vulnerable
RANIDAE	*Limnonectes magnus*	Philippine Endemic	Near Threatened
	Occidozyga laevis	Non-endemic	Least Concern
	Fejervarya cancrivora	Non-endemic	Least Concern
	Hylarana granducola	Mindanao Endemic	Least Concern
	Staurois natator	Non-endemic	Least Concern

Table-3
Relative abundance of frogs in two different habitat types in the lower montane forest and immediate vicinity of Mt. Kalatungan, Bukidnon

Species Name	Habitat Type				Over-All	
	Agricultural		Secondary Forest			
	Ni	RA (%)	Ni	RA (%)	Ni	RA (%)
Ansonia mcgregori	0	0	5	5.49	5	5.32
Ansonia muelleri	0	0	35	38.46	35	37.23
Kalophrynus pleurostigma	0	0	2	2.2	2	2.13
Limnonectes magnus	0	0	14	15.38	14	14.89
Megophrys stejnegeri	0	0	5	5.49	5	5.32
Occidozyga laevis	0	0	8	8.79	8	8.51
Pelophryne brevipes	0	0	2	2.2	2	2.13
Philautus acutirostris	0	0	4	4.40	4	4.26
Philautus worcesteri	0	0	1	1.1	1	1.06
Philautus surrufus	0	0	1	1.1	1	1.06
Philautus cf. *poecilus*	0	0	1	1.1	1	1.06
Polypedates leucomystax	2	67	4	4.40	6	6.38
Fejervarya cancrivora	0	0	2	2.2	2	2.13
Hylarana grandocula	1	33	0	0	1	10.6
Staurois natator	0	0	7	7.69	7	7.45
Total	3	100	91	100	94	100

Furthermore, Mt. Kalatungan's lower montane and immediate vicinity has many herbaceous plants that provide to some species of frogs, thus, it helps in the increase in amphibian population. This further supports the study conducted that site with greater herbaceous cover during rainy season support more amphibians (especially frogs) than sites with less herbaceous cover[16,17].

Species diversity in the lower montane and immediate vicinity of Mt. Kalatungan (H' = 2.145) is moderate, indicating conversion from a highly productive forest into a much less productive system (such as a grassland). Recent research shows that even extraction of natural resources and habitat fragmentation can lead to sudden drastic switches in the character of a forest ecosystem[18]. While many different factors can lead to such shits, a critical factor, for instance, is loss of resilience (the ability to recover from external events) through declining biodiversity at ecosystem level[19].

Table - 4
Frog diversity indices in the lower montane forest and immediate vicinity of Mt. Kalatungan, Bukidnon

Diversity indices	HABITAT TYPES		Total
	Agricultural	Secondary Forest	
Relative Abundance (RA)	3.2	96.8	100
Species Diversity (H')	0.637	1.508	2.145
Evenness (E)	0.918	0.125	0.792

In the lower montane and immediate vicinity of Mt. Kalatungan's secondary forest shows that it was inhabited by 14 species of amphibians, with H'=1.508. The abundance of decaying fallen logs in the area may have significant and potential effects on the populations of amphibians by providing them important retreat sites and increased diversity and abundance of invertebrate and vertebrate prey for many species of amphibians[20]. Despite the conversion of selected areas of the secondary forest within and near the declared buffer zone set by the Department of Environment and Natural resources (DENR)-Protected Areas and Wildlife Bureau (PAWB), the identified species of amphibians were still found to thrive in the area. However, such conversion of the forest by planting bananas *Musa sp.* in larger scale may have significantly contributed to the decline of species richness in the agricultural area. The species evenness in the lower montane and immediate vicinity of Mt. Kalatungan is moderate (E=0.792) which may be due to the hydrologic condition and food availability in the area. Evenness in the agricultural area (E=0.918) was higher than the secondary disturbed forest (E=0.125). This significant difference was probably due to the apparent dominance of two amphibian species namely, *Ansonia muelleri* (37.23%) and *Limnonectes magnus* (14.89%).

In the lower montane forest and immediate vicinity of Mt. Kalatungan all the frog species described were found in four microhabitat types namely, arboreal, leaf-axils, vertical stratum, and substrate level or ground litter microhabitat. A total of 10 species were found in Type IV microhabitat, substrate level or ground litter (table 5). Others were in different substrate levels. One species was observed to have a burrowing behavior such as *L. magnus* observed along the Sarukadang stream bed of Mt. Kalatungan. This burrowing behavior indicates the suitability of the substrate for burrowing ensuring the survival of the animal[21].

Table-5
Microhabitat preferences of amphibians in the lower montane forest and immediate vicinity of Mt. Kalatungan, Bukidnon, Philippines

Family	Scientific name	Microhabitat type	Microhabitat	Elevation (in masl)
BUFONIDAE	*Ansonia mcgregori*	IV only	Above rocks, rock crevices, along the trail, and in ground litters	1300-1500
BUFONIDAE	*Ansonia muelleri*	II and IV	On rocks, in forest floor, *Cyathea contaminans*	1300-1500
MICROHYALIDAE	*Kalophrynus pleurostigma*	IV only	On decaying fallen log, along the trail near the cave	1300-1500
RANIDAE	*Limnonectes magnus*	IV only	On the forest floor, on the rocks, stream bed, and inside the cave	1300-1500
MEGOPHRYIDAE	*Megophrys stejnegeri*	III and IV	On the forest floor leaf litters, in fallen logs, and in *Lithocarpus sp.* Buttres	1300-1500
BUFONIDAE	*Pelophryne brevipes*	III only	On tree bark (tungog) covered with mosses	1400-1500
RHACOPHORIDAE	*Philautus acutirostris*	I only	On *Musa sapientum,* in *M. textiles, Trema orientales,* in *Cyathea contaminans, Asplenium nidus,* and in tree epiphytes	1400-1500
	Philautus cf. *poecilus*	IV only	In forest floor	1400-1500
	Philautus surrufus	I only	*Asplenium nidus*	1400-1500
	Philautus worcesteri	III only	*Trema orientales* bark	1400-1500
	Polypedates leucomystax	IV only	On leaf litters, on rocks, and in *Paspalum conjugatum*	1300-1500
RANIDAE	*Occidozyga laevis*	IV only	Mountain stream	1356-1400
	Fejervarya cancrivora	IV only	On rocks, and in forest floor	1100-1300
	Hylarana grandocula	IV only	On rocks above flowing wáter	1100-1150
	Staurois natator	II only	On *Alocacia sp.* Leaf	1300-1356

While there are the existence of several species of frogs in the area, there are potential threats to their existence and survival (figure 5). The community of people in the area comprise 86 households with an average of 7 children most of whom were not able to reach high school because of poverty. Their major source of income is farming and selling forest products such as edible ferns, firewood (*Lithocarpus sp.),* baskets and mats. Expanding areas for planting value crops such as abaca, corn *(Zea mays),* cassava *(Manihot esculenta, Crantnz),* sweet potatoes *(Ipomoea batatas, Linn.),* carrots *(Daucus carota),* baguio beans (*Viga sp*.), bell pepper (*Capsicum annuum*), taro (*Colocasia sp*.), lettuce (*Meloidogyne sp*.), broccoli (*Brassica oleracea var*), and coffee (*Coffea arabica*) have contributed to the disturbance of the habitat of the frogs. Furthermore, the existence of many potential ecotourism sites in the area such as waterfalls and lakes, have also contributed to the influx of local tourists thus increasing the disturbance of the habitats of the amphibians. The operations of two logging concessionaires operating in the area leading to the rapid clearing of the forest have also increased human settlements and the conversion of the cleared forest to residential areas, farm lots, school site, etc.). Also, illegal mining activities were once operating in the falls, causing pollution in the area thus have may have affected other species aside from the amphibians.

To conserve biodiversity in the range, major restrictions to land use with the establishment of the Mt. Kalatungan Range Natural Park is being undertaken. However, the increasing demand for land use seems to continue: agricultural expansion and deforestation, both through *kaingin* (shifting cultivation) and wood extraction (conversion of primary or secondary forest to grassland). These are aggravated by human settlement expansion and if these will continue will considerably affect not only the amphibians but the flora and fauna of Mt. Kalatungan. To be able to avoid further decline of biodiversity, spatial policies should be in place. There is a need for support from the National Integrated Protected Areas Programme (NIPAS), a joint program of the Department of Environment and Natural Resources (DENR) and the European Union (EU) for the sustainable management of the area. Likewise, non-government organizations (NGOs) and local government units support the protection of the natural park by implementing livelihood-oriented projects for the communities around the vicinity of the mountain range park. It is important also that in the protected area, no new agricultural use or deforestation (either primary or secondary forest) may occur. Considering the existence of endemic species in the area, this is considered important in the national patrimony of the Philippines and should be protected and the flora and fauna including the amphibians should be conserved.

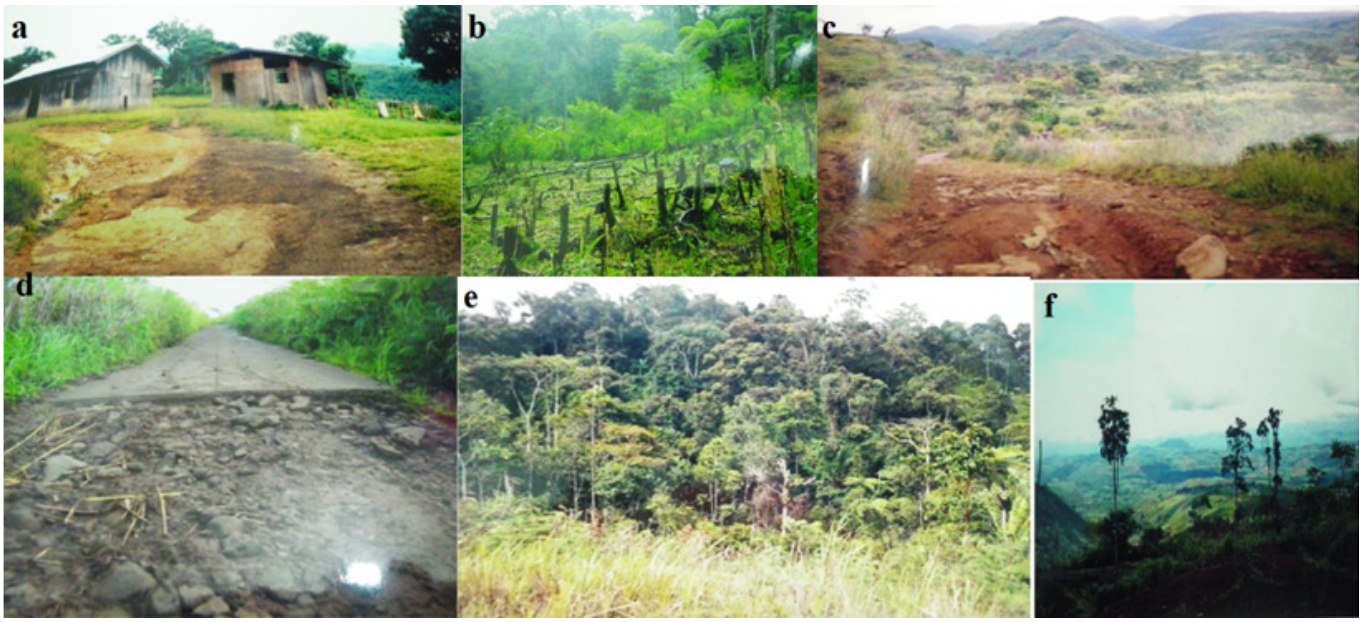

Figure - 5
Some threats in the vicinity of Mt. Kalatungan Range Park (left to right): human settlement, slash and burn (Kaingin), logging road, road to communities, agricultural land near the forest, denuded area in some areas of the park

Conclusion

The inventory of frogs in the agricultural and secondary forest of Mt. Kalatungan in Mindanao, Philippines showed eight Mindanao endemic five of which are vulnerable and one threatened species. Looking at the sources of hábitat destruction in the area threaten their possible demise. There is therefore a need of concerted effort in both government and other organizations for the protction and conservation of their hábitats.

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