Abundance, Distribution and Conservation Status of Reptiles in Agusan Marsh, Bunawan, Agusan Del Sur, Philippines

[1]Meconcepcion M. Ngilangil, [2]Lilia Z. Boyles and [2]Rainer P. Sularte

***Abstract*—**The study was concerned about the ecological or biodiversity threats among reptiles which are becoming endangered or worst extinct. Agusan Marsh Wildlife Sanctuary is one of the most significant and unique wetlands in the Philippines. This study was the first systematic investigation of reptile species on the marsh. This study aimed to conduct a systematic study on reptiles in Sago swamp and Terminalia forest, Agusan Marsh. The methods used were a combination of quadrat method, pitfall trap and opportunistic during September to December 2013. The study found out that eleven (11) species belonging to seven (7) families, with a total of 237 individuals were documented in both sampling sites. Five species were recorded as Philippine endemic namely; *Hydrosaurus pustulatus, Naja philippinensis, Draco quadrasi, Tropidophorus davaoensis* and *Tropidophorus misaminius*. Among the five endemic species, *Tropidophorus davaoensis* and *Tropidophorus misaminius* were Mindanao endemic. Both sampling sites documented high diversity and more or less even distribution. The association of environmental variables with bushes, coconut trees, leaf litter and tree trunk, selectively logs shows stronger correlation with reptilian species such as *Eutropis cumingi*, *Draco quadrasi*, and *Emoia atrocostata*. Despite the exceedingly small land coverage, the Sago swamp and Terminalia forest were confronting threats due to unprecedented human activities. Conservation action is essential to protect and preserve biodiversity in the entire Agusan Marsh.

***Keywords*—** Herpetology, Agusan Marsh, microhabitat, reptilian species, experimental design, Philippines.

I. Introduction

PHILIPPINE archipelago was home to a spectacular and diverse assemblage of amphibians and reptiles. Situated at the interface between the Oriental and Australian faunal zones has now collectively recognized as one of the most important center of herpetofaunal diversity in South East Asia. Philippine herpetofauna was far richer, the levels of endemicity were much higher and the evolutionary history was far more complex than have been assumed (Diesmos et al., 2002).

By itself, CARAGA or Region 13 (Surigao del Norte, Surigao del Sur, Agusan del Norte and Agusan del Sur) has a rich ecosystem and hosts a unique community of plant and animal species. Agusan Marsh has been declared a Wildlife Sanctuary (AMWS) and one of the 128 key biodiversity area (KBA) as well as one of the top 10 priority protected areas in the Integrated Protected Areas System (IPAS). CARAGA's species diversity was also high for amphibians (26%) and reptiles (62%). The region has 16 endemic amphibians species (42%) and 36 endemic reptiles (53%) (Hilario, 2010). Still, the region was also not spared from ecological or biodiversity threats. Sooner or later, all these species will diminish, be endangered and worst, become extinct. Thus, the study focuses on reptile species solely.

Reptile species provide a critical role in ecosystems as predators, and as a group show great diversity in the tropics and because of their biological and ecological characteristics, it serves as good environmental indicators, providing an excellent starting point for inventorying and monitoring biodiversity.

Despite a handful of local people dedicated to conservation, the threats to the remaining forest on the mountain are imminent, leaving an opportunity of perhaps only few years to study species and ecosystems and to change the current trajectory to better preserve the marsh. Information that will be gathered from this study can contribute to the existing scanty knowledge on reptiles especially in Agusan Marsh. Thus, the study will have an extrapolative value for the conservation management of the reptile community in other areas as well. This study endeavors to conduct a systematic study on reptiles in Sago swamp and Terminalia forest, Agusan Marsh that aims to do the following: determine the ecological conditions of Sago Palm (*Metroxylon sagu*) stands and Terminalia Forest; determine and compare the species distribution and abundance between Sago Palm and Terminalia Forest; determine conservation status of reptiles between two vegetation types; lastly, recommend conservation measures between two vegetation types of Agusan Marsh.

II. Materials And Methods

A. The Study Area

Agusan Marsh was a vast complex of freshwater marshes and water courses with numerous shallow lakes and ponds in the upper basin of the Agusan River and its tributaries. It was located in the province of Agusan del Sur, Northeastern Mindanao, Philippines which covers an area of 65,806 hectares of which 19,196 hectares was a proclaimed sanctuary

[1]Ngilangil, Meconcepcion M., St. Paul University- Surigao, Surigao City, Philippines, 8400. (Email add: vancouver_samantha_khan@yahoo.com).
[2]Caraga State University, Ampayon, Butuan City, Philippines, 8600.

(Almeria, 2013). It covers a portion of eight municipalities (Primavera and Tumanda as cited by Almeria & Nuñeza, 2013) on which Bunawan was one of the municipalities. Bunawan, on the other hand, covers several barangays that includes Sitio Kaliluan where Sago swamp and Terminalia forest were found (Figure1).

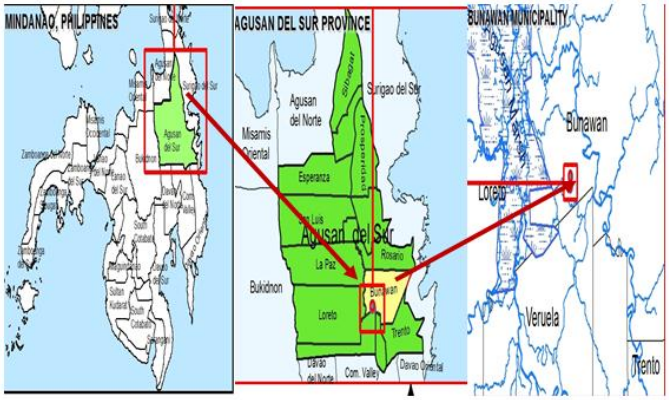

Fig. 1 Map of Agusan del Sur showing the two sampling area in Bunawan.

B. Sampling Sites

Two sampling sites were established as anchored in Almeria & Nuñeza (2013). Sampling site 1, Terminalia Forest was situated at 08° 09.825' North latitude and 125° 58.044 East longitude. Most of the area was flooded with water and a stream was found within the sampling area. Terminalia forest was a flat primary forest dominated by *Terminalia copelandii* Elm. and *Terminalia calamansanay* Rolfe under Family Combretaceae. Canopy epiphytes, canopy vines, understory plants and rare patches of grasses or sedges were found. Fruit trees and mosses of about 10% cover were present. Depth of humus cover was about 4 inches with alluvium and clay loam soil type. There were few logs; no exposed rocks (Almeria & Nuñeza, 2013).

Sampling site 2, Sago swamp forest was situated at 08° 09.825' North latitude and 125° 57.637' East longitude. It was about 300 hectares and has a relatively flat slope. The sampling area, constantly flooded with water, has series of brooks and streams. Water level ranged from 9 to 15 inches. The Sago swamp forest was a secondary growth of *Metroxylon sagu* or "sago" under the Palm family Arecaceae. Pitcher plant was found; moss density was about 40%; leaf litter was 90% and the depth of humus cover was about one foot with sandy loam soil; fallen logs were minimal caused by storm (Almeria & Nuñeza, 2013).

C. Species Inventory

To achieve the inventory of reptile species, specimens was collected in three ways: survey transects, pitfall trap method and opportunistic collection. These techniques employed intensive sampling of arboreal, surface and subterranean strata in the chosen sites (Almeria & Nuñeza, 2013). Two transect line (1km) with three quadrats of about 20x20 m was laid down randomly in each sampling site with 20m away from each quadrat. It was conducted last September to December 2013.

The researcher, along with the local participants and experts of reptiles conducted two camping trip every day (morning and night on the marsh during the research period. Each camping trip for every site lasted 4 hours and multiple surveys transects (three on average) conducted on each trip (Beukema, 2012). Surveys targeted higher elevations where species endemism would potentially be higher and where there was less human disturbance. Surveys at different sites completed within the same time period as much as possible to minimize differences arising from weather, seasonal, or other changes and no surveys conducted during vey inclement weather (Ward, 2012). Each survey quadrat lasted up to 1 hour. Weather permitting, and a day and a night survey done on the same date, if possible.

Collected samples were identified right away by experts and were tagged, photographed on the dorsal, lateral and ventral sides to facilitate scale counts (Beukema, 2011) and released back into the field. One to two voucher specimens were prepared especially for species not identified in the field (Heyer et al, 1994). Those species with unsure identification were verified using taxonomic keys of Alcala (1986) and Diesmos et al. (2008) for turtles, Brown and Alcala (1978) as modified by Brown et al. (2007,2008) and Zug et al (2007) for gekkonid lizards, Brown and Alcala (1980) and Mausfeld et al. (2002) for scincid lizards, Koch et al. (2007) for varanid lizards. Taxonomy of snakes followed Leviton (1964a; 1964b; 1967; 1970b),Ota and Ross (1994) and Utiger et al., (2005). Then, it was sent to experts in herpetofauna, Dr. Arvin Diesmos of National Museum of the Philippines and Dr. Rafe Brown from University of Kansas for identification confirmation. Regardless of collection method, if a specimen represented a species previously collected, the specimen was released. If it is a species not previously collected in the study, the specimen will be retained and later euthanized by an injection of lidocaine. Specimens were preserved with a 10% formalin solution and later stored in 70% ethanol (Ward, 2012).

A one-way Anova at 0.05 alpha levels was used to test whether there is any significant difference in the means of diversity in the two habitat types of Agusan Marsh.

D. Microhabitat Analysis

Sample specimens were collected either on a survey or opportunistic collection. Notes were taken on the microhabitat to help determine the conservation needs of each species. Microhabitat descriptions in the filed notes included specific details such as physical characteristics (grass, humus, bare soil, stream banks, on the ground, etc.) and associated vegetation (Ward, 2012), including the species name when possible. The descriptions were grouped into more general categories such as leaf litter, rotting log, tree trunk, tree branches/ leaves, ground cover vegetation and others (Neal, 2007). Because many specimens were opportunistic collections, human-made objects (such as houses or equipment in people's yards) and human- maintained vegetation (such as farms, gardens and roadsides) were used as microhabitat categories (Kati, 2007).

III. Results And Discussion

The *Sago* Palm area was a secondary forest dominated by *Metroxylon sagu* under the Palm family Arecaceae and it was about 3 hectares with a vegetation type composed primarily of tall grass, vines, shrubs, and epiphytes. There were other trees spotted in the area like Lanipao, Wango, Manga Pajo, Kabihid and Libas. While few of Baas, Panabog, Dagahit and Ferns (Pako) were also noted. The observed bed floor of *Sago* Palm was watery with the presence of rotten logs and leaf litters while the soil type was peat lands (Figure 2). Peat lands were wetlands with a thick water-logged organic soil layer (peat) made up of dead and decaying plant material as documented by Santillan *et al* (2012). The distance from the sampling site to anthropogenic clearing of a large scale rice plantation and human settlement was about 50 meters. An abandoned slash and burn farm was observed at the periphery of the sampling site as also noted by the study of Almeria & Nuñeza (2013).

Terminalia Forest was a flat primary forest dominated by *Terminalia copelandii* under Family Combretaceae. The vegetation type of this area was composed of tall grass, vines, shrubs, and epiphytes. Tree taxa of Terminalia forest were primarily composed of Manga Pajo, Maymayan, Lanipao, Katumbawon, Kapi-kapi, Salumbayan, Tayapok and Hambabawod. Some of the trees produce fruits that were eaten by endemic birds in the area. Dominate grasses found in the area include Baas, Bagahit, Bakong, Tambo, Muti-muti and Bangiba. While, ground cover plants such Fern and Fern-allies, Pitcher plant, and Badyang were recorded. Most of the area was flooded with water and a small stream was found within the sampling area. Rotten logs, left litters and tree holes were documented but no exposed rocks. Soil type was clay loam and presence of depth humus cover was also noted. The distance from the sampling site to anthropogenic clearing and human settlements was approximately 50 meters. Slash and burn can be observed few meters away from the sampling site.

Environmental parameters in the two vegetation types of Agusan Marsh were recorded such as ambient temperature; wet temperature was 31°C while dry temperature was 30°C. The sky during the day was partly cloudy but varied every day during the fieldworks. Relative humidity was 79% while vapour pressure (mmHg) 23.75 mm while the dew point temperature was 42.6 dc. In addition, rainfall (mm) during the sampling period was 376.7 and the average wind speed (mps) was 002 (Data taken from Hinatuan Weather Station).

Habitat quality was a measure of the importance of habitat type in maintaining a particular species (Van Horne, 1983).

In the CCA ordination (Figure 3) sampling site 1.1 and 1.2 shows particular environmental patterns. The association of environmental variables with bushes, coconut trees, leaf litter and tree trunk, selectively logs shows stronger correlation with reptilian species such as *Eutropis cumingi*, *Draco quadrasi*, *Emoia atrocostata*. On the upper- right quadrat, *Hydrosaurus pustulatus*, *Tropidophorus davaoensis* shows its stronger relation in the human maintain vegetation in sampling station 1.1. *Naja philippinensis* shows its apparent association with environmental variable with road kills, in sampling station 1.1

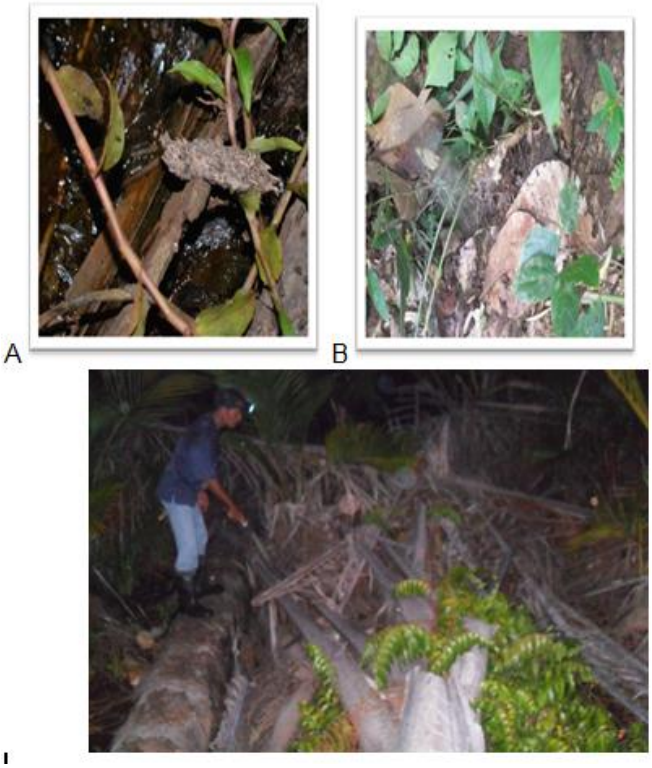

Fig. 2. Natural habitats on ground dwelling (A), leaf litter (B) and rotten sago and log trunks (C)

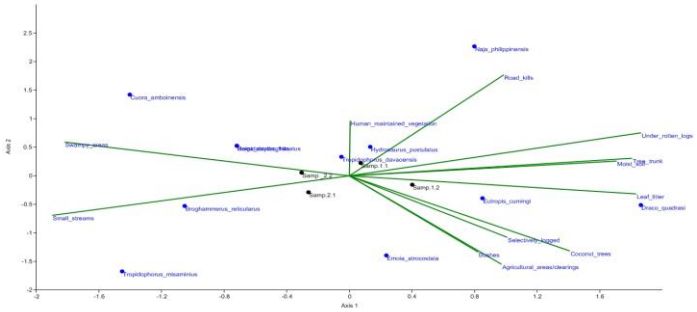

Fig. 3. Ordination of species and environmental variables in the first two canonical axis from CCA scores.

Moreover, the clustering of species and environmental variables with swampy areas and small streams shows strong association with *Cuora amboinensis*, this can be explained that this species prefers this specific environment. With reference to study of Hofer et al., 2000, that response of reptiles to streams shows pronounced preference as it gives large CCA score, thus its abundance affects stronger relation to its environment. Species that negatively correlates small streams *Tropidophorus misaminius* and *Broghammerus reticularus*, this species were given small weight in the CCA.

Species Distribution and Abundance

Sago swamp and Terminalia forest both documented 11 species of reptiles belonging to seven (7) Families Agamidae, Elapidae, Gekkonidae, Geomyididae, Pythonidae, Scincidae and Colubridae, including, 7 lizards, 3 snakes and 1 turtle

Fig. 4 The Eleven (11) documented species namely (L-R); *Hydrosaurus pustulatus, Emoia atrocostata, Hemidactylus frenatus, Broghammerus reticularus, Cuora amboinensis, Draco quadrasi, Eutropis cumingi, Tropidophorus misaminius, Tropidophorus misaminius, Boiga dendrophila divergens, and Naja philippinensis.*

A total of 237 individuals were documented, in the Sago swamp forest (113) and Terminalia forest (124) for the whole duration of the study. The three techniques namely, survey transects, pitfall trap method and opportunistic collection were employed in the study. Pitfall traps sampled a lower number of individuals and species than the other two methods, but was more efficient for sampling one particular species, the *Emoia atrocostata*. In a study of Almeida-Gomes et al., (2008) at Atlantic rainforest area in Rio de Janeiro State, pit-falls also seemed not efficient than the other methods. Most opportunistic collections were contributed by people in the locality or found while on camping trips but not during the actual survey transects. The Sago plants (Metroxylon species) with a distinctive features of elongated large leaves that are provided with sharp spiny thorns that accumulate on the forest floors of the Sago palm forest as cited by Almeria & Nuñeza, 2013 made it difficult for the researchers and local guide to penetrate on the area; only highly adapted or tolerant species may be able to cope with this condition (Miller et al., 2001 as cited by Almeria & Nuñeza, 2013).

Terminalia forest was a watery area dominated with tall grasses and trees and the canopy of trees are very close from one another. The adjacent area of Terminalia forest was rice fields where insects and other micro-pests lived, this insects and micro-pests serves as food. In addition, frequent rainfall increase the density of food resources of reptiles, probability of breeding, larval survival and juvenile recruitment (Gray et al., 2004, as cited by Almeria & Nuñeza, 2013) gave a contributing factor of species abundance. On the other hand, Terminalia forest was the most extensive area left in the Philippines on which historical records indicate that this kind of forest was fairly common in marshes in the country. However, most of the Terminalia forest has been cleared; hence, it was particularly vulnerable to clearing (RAMSAR, 2000)

TABLE I
SPECIES DIVERSITY AND EVENNESS OF REPTILES IN THE TWO SAMPLING SITES IN AGUSAN MARSH.

	SAGO PALM	TERMINALIA FOREST
Taxa_S	11	11
Individuals	113	124
Dominance_D	0.1306	0.1206
Simpson_1-D	0.8694	0.8794
Shannon_H	2.16	2.196
Evenness_e^H/S	0.7886	0.8171

A slightly higher diversity was recorded in the Terminalia forest (H' = 2.196) compared to Sago swamp forest (H' = 2.16). This implies that Terminalia Forest had rich number of number of individuals may be due to more favourable habitat types for herpetofauna such as close canopy of trees with tall grasses, watery bed floor, adjacent to herbaceous-swamp and suitable climatic conditions such temperature. Rainfall (378mm-528.8mm) was high in Terminalia making the area more productive. Floodplains and large woody debris in the Terminalia forest were abundant as cited by Almeria & Nuñeza, 2013. Active floodplain, vegetated islands and large woody debris are important, directly and indirectly, in maintaining both habitat and herpetofauna diversity and density (Klaus et al., 2006 as cited by Almeria & Nuñeza, 2013).

On the other hand, the computed species evenness in the two habitat types, Sago Palm (0.7886) and Terminalia Forest (0.8171) was moderate that might be for the reason of having almost the same parameters such seasonal variation, elevation range, habitat type and availability of foods. Combination of factors that favored speciation in the past, including fluctuating sea levels (created habitats with equable climatic conditions) , complex geologic (tectonic) events (favoring creation of many microhabitats) and promoting geographic barriers to population mixing made it a reason for high species richness and high endemism (Heaney 1985; Sodhi et al. 2004; Brown & Diesmos2009).

Conservation Status

The researcher documented species that were under conservation status, including 2 vulnerable/ decreasing, 7 least concern/stable and 2 near threatened/decreasing Five species named *Hydrosaurus pustulatus, Naja philippinensis, Draco quadrasi, Tropidophorus davaoensis* and *Tropidophorus misaminius* were documented living only (endemic) in the Philippines based on the IUCN 2007. Among the 5 endemic species, *Tropidophorus davaoensis* and *Tropidophorus misaminius* were considered as Mindanao endemic (Amoroso, 2000 as cited by Beukema, 2011). With reference to the 2007 IUCN Red Data List, the researcher identified three endemic species with Least Concern/stable conservation status; these include *Draco quadrasi, Tropidophorus davaoensis* and *Tropidophorus misaminius*, while *Hemidactylus frenatus, Broghammerus reticularus* and *Emoia atrocostata* which are not endemic were also in Least Concern status. While *Naja philippinensis* and *Boiga dendrophila divergens* were near threatened and also decreasing. Killings of snakes accidental along the road were observed. Ashley and Robinson (1996), as cited by Sharma

(2011), observed that the road-kills of reptile are a major cause of mortality for a wide variety of taxa. *Hydrosaurus pustulatus* and *Cuora amboinensis* were identified as vulnerable and likely decreasing. Raising of *Cuora amboinensis* for pet and food consumption were observed in the locality. Harvesting of herpetofauna through illegal trade and unsustainable consumption was probably the biggest threat other than habitat destruction and alteration as cited by Neal (2007). (Zug et al., 2001).

Though, this study accounted only 11 (17.8%) species with 2 (5.5%) were endemic (*Tropidophorus davaoensis* and *Tropidophorus misaminius*) this does not exactly indicate reptile species decline in Agusan Marsh as the surveys were encountered only for four months. This decrease could be due to either samples being missed, especially if individuals are small in size and residing in the clumped leaf litter, species being well camouflaged, or the ability of individuals to escape even before they were noticed (Ates- Camino et al., 2010). In addition, the researcher supposes that the swifter nature of reptiles compared to amphibians and their limited of absence of vocalization may have account for their rarity of capture.

Environmental Threats and Conservation Management

Despite the exceedingly small land coverage, the Sago swamp and Terminalia forest was confronting threats due to unprecedented human activities. Today, the major threat of reptile species in Agusan Marsh was the on-going conversion of Sago and Terminalia Forest into agricultural land (Figure 5A,B). Local residents such as the Manobo have cleared portions for corn, vegetable and rice production. The agricultural chemicals and pesticides used in corn, vegetable and rice production results in secondary problems for herpetofaunal communities with the mass killing of insect communities, which was an integral component of their food niche (Bishop and Gendron, 1998; Somaweera, 2001; Bambaradeniya, 2001 as cited by Surasinghe & Jayaratne ,2006). Besides, there was a tendency for bioaccumulation and biomagnification of the pesticides to occur through food webs (Moriarty, 1975; Feleers et al., 2004 as cited by Surasinghe & Jayaratne , 2006)

Fig. 5On-going anthropogenic activities inside Sago Palm and Terminalia Forest of Agusan Marsh.

Cutting and clearing of Terminalia trees for charcoal making and firewood production as well as harvesting (hunting/gathering) of wildlife vertebrates for food consumption (wild pig capture) were the present livelihood of some local residents in the area. Like the species *Cuora amboinensis* on the study of Brown et al., 2012, it was heavily hunted for food, curiosities, pet trade and traditional medicine which were also observed in the locality of Agusan Marsh. Hence, extraction of forest resources by the villages of the forest perimeter was leading to overexploitation, and enhancing extent of disturbances (Surasinghe & Jayaratne, 2006). On the other hand, Kaingin or Slush and Burns (Figure 5C) in the area were noted during our field sampling. This not only destroys the habitats but also directly kills the reptile and amphibian species. Moreover, burning would hinder the development of the secondary successions. In certain situations, fire spreads even into the core-forest areas causing significant degree habitat destruction (Surasinghe & Jayaratne, 2006). With the ongoing disturbances in the Agusan Marsh, it appears that the endemic species are more at risk (Almeria & Nuñeza, 2013). Poynton et al., (2007), as cited by Almeria & Nuñeza, 2013), reported that the uniqueness of the species combined with their evident vulnerability to disturbance make them a subject for particular conservation.

The researcher come up with these policies for conservation management; first, a legal framework must be established to prevent disturbances, especially encroachments and forest-resource overexploitation and the law enforcement should be functional to take legal action against violation of rules; second, a pilot project was also need to carry out to monitor the population status of reptile species and the biotic and anthropogenic factors affecting those; third, the landowners of the nearby private agricultural lands must be encouraged to adopt agroforestry practices. This will allow establishment of small populations of herpetofauna that can function as subpopulations. Later on, such small populations will interbreed with the main populations in the reserve and will create metapopulations; lastly, forest management should target the maintenance of the open forest structure with low bush under growth, to favor the diversity of terrestrial reptiles (Surasinghe & Jayaratne, 2006).

IV. Conclusion

Sago plam and Terminalia forest still harbour unique community of reptilian species regardless of the on-going anthropogenic activities in the area like Kaingin, conversion of lands to agriculture and harvesting of species for pet trade, medicine, and food consumption in the rest of Agusan Marsh are any indication that the clock was ticking on this unique and valuable ecological refuge. Data from this study suggest that reptiles in Terminalia Forest and Sago Palm need urgent protective measures and management including other wildlife faunal species in the area. Protection and conservation priorities of the reptilian species and long-term monitoring programmes within the Sago palm and Terminalia forest of Agusan Marsh will be closely monitored by our local and provincial government and some non-government organizations (NGOs) in the country.

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Meconcepcion M. Ngilangil was born on December 7, 1987 in Cabadbaran City, Agusan del Norte, Philippines. She was a graduate of Bachelor of Science in Biology in Mindanao State University- Main Campus, Marawi City, Philippines last November 2008. She also finished her Master of Science in Biology major in Physiology at Caraga State University, Ampayon, Butuan City, Philippines last Nov. 2014. She was a member of Philippine Society of the Study of Nature (PSSN). Now, she is currently employed at St. Paul University- Surigao, Surigao City, Philippines as Research Coordinator.