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Rapid assessment of anurans of Panigan-Tamugan watershed, Davao City, Mindanao Island, Philippines

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Abstract

Data on anurans in Davao City watersheds remains depauperate. This study provides the first account of anurans of the Panigan-Tamugan watershed using visual encounter survey (VES) and microhabitat searches along fifteen 10 × 10 m belt transects. A total of 14 species belonging to 11 genera and five families were recorded for all three sampling sites in the Panigan-Tamugan Watershed. Eleven out of 14 anurans species documented in this survey are endemic to the Philippines. Anuran families recorded during the survey included Bufonidae Gray (n= 3), Dicroglossidae Anderson (n= 4), Megophryidae Bonaparte (n= 2), Ranidae Batsch (n= 1), and Rhacophoridae Hoffman (n= 4). Additional records of anurans from this study, namely *Fejervarya vittigera* (Wiegmann), *Occidozyga laevis* (Günther), *Pelophryne brevipes* (Peters), and *Philautus worcesteri* (Stejneger), increased the number of species known from watershed areas of Davao City, as they were not reported in previous inventories conducted in the city. Species richness data may not necessarily reflect the true number of species in the site. Future studies should include an increased number of transects and man hours. Although the list comprises the limited information on this taxon in watersheds, more inventories are necessary for a full understanding of anuran composition in the city's several watersheds.

Key words: Anuran species checklist, Mindanao endemic anurans, Philippine wildlife, watershed anuran inventory

The Philippines is part of the Indomalayan region that comprises the Indian subcontinent, Southeast Asian forests, and Malaysia to Indonesia ecoregions (Bain et al., 2006). Anurans known from the country, based on the most recent list in the Amphibian Species of the World Database, included 113 species represented by 9 families and 31 genera (Frost, 2021). Although the number of anuran species in the

Philippines is lower compared to that in Indonesia (n= 436), India (n= 415), and Malaysia (n= 279) (Frost, 2021), the Philippines has the highest rate of endemicity (> 80%) in the Indomalayan region (Bain et al., 2006; Diesmos et al., 2015; Frost, 2021). This is in comparison to India (= 72.29%), Indonesia (= 51.61%), and Malaysia (= 39.42%) (AmphibiaWeb, 2022). The current count is expected to increase with more data from local inventory studies (Diesmos et al., 2015; Sanguila et al., 2016). Efforts on anuran inventory and assessment to provide data on anuran diversity in Mindanao Island were carried out in different rural localities and mountain ranges (Relox et al., 2011; Warguez et al., 2013; Plaza and Sanguila, 2015; Sanguila et al., 2016; Toledo-Bruno et al., 2017; Coritico et al., 2018; Solania and Fernandez-Gamalinda, 2018; Vidal et al., 2018; Delima-Baron et al., 2021), while anuran inventories conducted within Davao City, particularly its watersheds, are lacking. Watersheds are important habitats for water-dependent organisms, including anurans (Salo and Solania, 2022). Anurans are dependent on their habitat, and changes in water and soil quality may impact their survival (Bishop et al., 2012). Their sensitivity to their immediate environment makes them excellent biological indicators of watershed health and stresses (Sumanasekara et al., 2015).

To date, there are only six accessible papers related to anuran studies in urban and forested areas in Davao City, but not in sites declared as watershed (Apayor-Ynot et al., 2017; Dacalus et al., 2017; Jabon et al., 2019; Delima-Baron et al., 2019; Gersava et al., 2020; Delima-Baron et al., 2022). The technical report of Ibañez et al. (2012) that accounted for 18 species of anurans in the Talomo-Lipadas watershed is the only accessible report of anurans in Davao City's watershed areas. No published information is currently available disclosing anuran species composition in other watersheds in the city including the Panigan-Tamugan watershed. The present study is the first to account for the anurans in the Panigan-Tamugan watershed. The data provided by this current study will not only aggregate knowledge on anurans in Davao City's watershed areas but will also provide baseline information on anurans that can be utilized in future assessments of watershed health since anurans may be used as biological indicators in freshwater habitats because of their abundance (Burger and Snodgrass, 1998) and sensitivity to pollution (Sumanasekara et al., 2015).

Three sites were identified within the Panigan-Tamugan watershed located in Barangay Carmen, Baguio District, Davao City, Philippines (Fig. 1). These included Site 1: Montane forest (7°07.303' N, 125°18.555' E; 1464–1478 m a.s.l.), Site 2: Dipterocarp forest (7°07.307' N, 125°18.588' E; 1405–1477 m a.s.l.), and Site 3: Agroforest ecosystem (7°07.026' N, 125°19.410' E; 1059–1090 m a.s.l.) (Fig. 2). The survey was conducted from 24 to 31 January 2021. Weather during the nocturnal survey was rainy with an average air temperature and humidity of 18.5 °C and 98.33%, respectively. Photographs of the sampling areas and specimens were taken using a digital camera (Nikon D500). Coordinates were recorded using a Garmin Etrex 10 GPS Tracker and a map was generated using QGIS 3.22.12 Białowieża software.

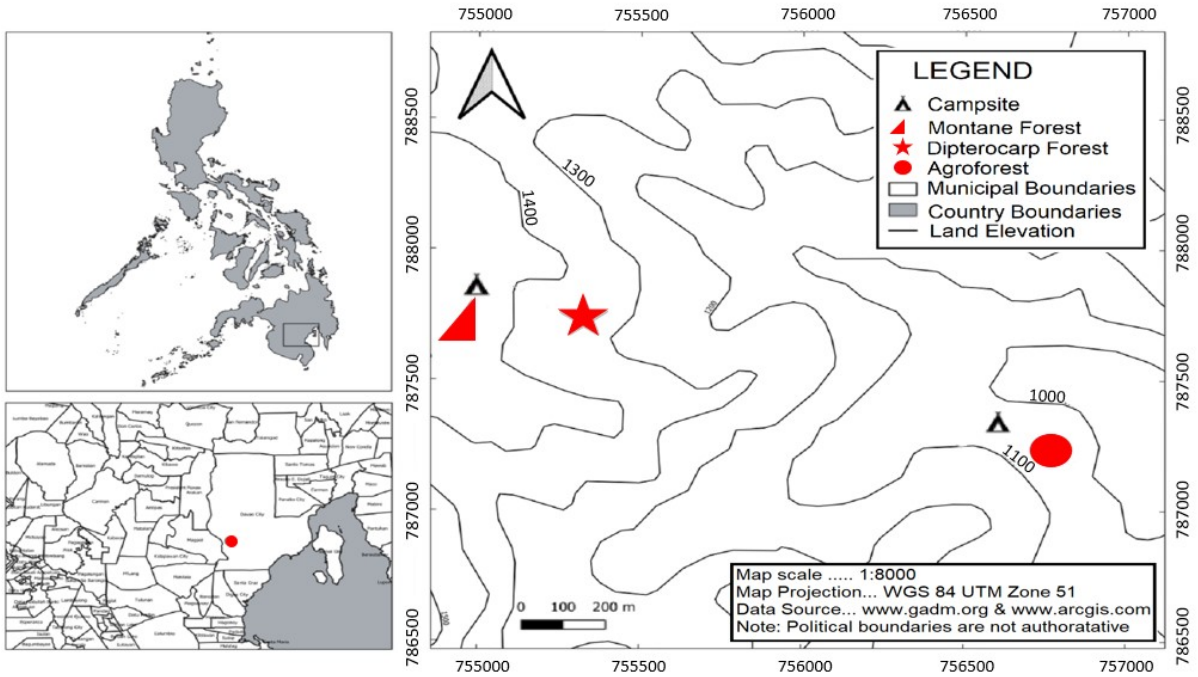

Figure 1: Contour map showing the three sampling sites where sampling points were established in the Panigan-Tamugan watershed, Barangay Carmen, Davao City, Philippines.

Figure 2: Sampling sites established in the Panigan-Tamugan watershed, Barangay Carmen, Davao City, Philippines: A – Montane forest (Site 1), B – Dipterocarp forest (Site 2), and Agroforest ecosystem (Site 3) including C1 – Entrance near the forest and C2 – site near the farm road.

Fifteen belt transect lines (10 m long ×10 m wide) were established on each site. A time-constrained search method was used wherein each belt transect was searched by one observer for two hours (Causaren et al., 2016). Sampling was done from 18:00 to 20:30. Three observers surveyed each transect for 10 minutes. All microhabitats of anurans were thoroughly searched. Anurans found within the transect were captured and placed inside collection bags. Collected anurans were taken back to the campsite for identification and voucher specimen preparation.

Species were identified based on the standard morphological features and related biometrics for anurans (Watters et al., 2016) including snout-vent length (SVL), weight, and other observations. The SVL and weight are provided in millimeter and grams, respectively. Identification was based on the morphological characteristics described by Alcala and Brown (1998), but supplemental descriptions from other publications were also consulted (Warguez et al., 2013; Sanguila et al., 2016; Delima-Baron et al., 2021). Species identifications were verified by Dr. Elsa May Delima-Baron. Voucher specimens were collected for some individuals following specifications of the Gratuitous Permit issued by the Department of the Environment and Natural Resources Region XI (GP No: XI-2020-08) and DMSF IACUC (IACUC No. 2020-02-002). Representative individuals were prepared for vouchers following the procedure of Heyer et al. (1994). Specimens were euthanized by directly injecting 95% ethanol to the cardiac region. Specimens were placed in air-tight plastic containers, preserved in 10% buffered formaldehyde, and were eventually stored in 70% alcohol in the laboratory of San Pedro College in Davao City, Philippines. Specimens were tagged with codes following the initials of the first author (MDT 0001–MDT 0095).

A total of 14 species belonging to 11 genera and five families were recorded for all three sampling sites in the Panigan-Tamugan watershed: Bufonidae (n= 3), Dicroglossidae (n= 4), Megophryidae (n= 2), Ranidae (n= 1), and Rhacophoridae (n= 4) (Figs. 3–16). The inventory documented 11 endemic species, two native species *Occidozyga laevis* (Günther, 1858), and *Polypedates leucomystax* (Gravenhorst, 1829), and one exotic species *Rhinella marina* (Linnaeus, 1758) (Frost, 2021) (Table 1).

The species richness of anurans recorded in this study was lower compared to previous reports in other watersheds: 17 from Talomo-Lipadas (Ibañez et al., 2012) and 20 from Taguibo (Sanguila et al., 2020). Although the species richness of anurans in this study was low compared with those accounted from the

Talomo-Lipadas watershed, additional records of *Fejervarya vittigera* (Wiegmann, 1834), *O. laevis*, *Pelophryne brevipes* (Peters, 1867), and *Philautus worcesteri* (Stejneger, 1905) were added to the current list of species known from watershed areas of Davao City. The low species richness may be attributed to the reduced areas surveyed, single-season sampling, and time-constrained search. Given these limitations, there is a need to augment sampling efforts in the Tamugan-Panigan watershed to determine if the current species list presented in this paper really represents the complete species count in the watershed.

The high number of endemic species from the forested sites (8 out of 11) parallels the previous report of Nuñeza et al. (2010) in that endemic species are more frequently encountered in the forested habitats. Observations including those of this study, also magnify accounts of high anuran endemism in the Mindanao watersheds (Solania and Fernandez-Gamalinda, 2018; Sanguila et al., 2020; Salo and Solania, 2022).

The presence of the Near Threatened species *Limnonectes magnus* (Stejneger, 1910) in this study was also accounted by the previous anuran inventories in Mindanao watersheds (Solania and Fernandez-Gamalinda, 2018; Sanguila et al., 2020; Salo and Solania, 2022). This amplifies the value of watersheds as important habitats for endemic anurans. The occurrence of *R. marina*, however, magnifies a disturbance-posing threat to both watershed health and anuran composition due to its invasive nature. Although this species was not accounted in the forested areas surveyed and its edges, its presence within the Panigan-Tamugan watershed can be used as a basis for the evaluation of current watershed management initiatives.

Figure 3: *Ansonia muelleri* (Boulenger, 1887). Photo by E.M.D. Baron.

Figure 4: *Pelophryne brevipes* (Peters, 1867). Photo by M.D.T. Tagoon.

Figure 5: *Rhinella marina* (Linnaeus, 1758). Photo by M.D.T. Tagoon.

Figure 6: *Limnonectes leytensis* (Boettger, 1893). Photo by M.D.T. Tagoon.

Figure 7: *Limnonectes magnus* (Stejneger, 1910). Photo by M.D.T. Tagoon.

Figure 8: *Fejervarya vittigera* (Wiegmann, 1834). Photo by M.D.T. Tagoon.

Figure 9: *Occidozyga laevis* (Günther, 1858). Photo by M.D.T. Tagoon.

Figure 10: *Pelobatrachus stejnegeri* (Taylor, 1920). Photo by E.M.D. Baron.

Figure 11: *Leptobrachium lumadorum* Brown, Siler, Diesmos, and Alcala, 2010. Photo by E.M.D. Baron.

Figure 12: *Philautus worcesteri* (Stejneger, 1905). Photo by M.D.T. Tagoon.

Figure 13: *Philautus surdus* (Peters, 1863). Photo by M.D.T. Tagoon.

Figure 14: *Philautus acutirostris* (Peters, 1867). Photo by E.M.D. Baron.

Figure 15: *Polypedates leucomystax* (Gravenhorst, 1829). Photo by M.D.T. Tagoon.

Figure 16: *Pulchrana grandocula* (Taylor, 1920). Photo by M.D.T. Tagoon.

Table 1: Comparison of reports on anurans known from watersheds in Davao City.

Family	Scientific Name	IUCN Status	Talomo-Lipadas (Ibañez et al. 2012)	Panigan-Tamugan (current study)
Bufonidae	*Rhinella marina* (Linnaeus, 1758)	#LC		(Site 3)
	Ansonia muelleri (Boulenger, 1887)	*LC		(Site 1)
	Pelophryne brevipes (Peters, 1867)	*LC		(Site 2)
Ceratobatrachidae	*Platymantis* cf *guentheri* (Boulenger, 1882)	*LC		
Dicroglossidae	*Limnonectes magnus* (Stejneger, 1910)	*LC		(Site 1 and 3)
	Limnonectes leytensis (Boettger, 1893)	*LC		(Site 3)
	Fejervarya vittigera (Wiegmann, 1834)	*LC		(Site 3)
	Fejervarya moodiei (Taylor, 1920)	+LC		
	Occidozyga laevis (Günther, 1858)	+LC		(Site 3)
Megophryidae	*Leptobrachium lumadorum* Brown, Siler, Diesmos, and Alcala, 2010	*LC		(Site 1 and 2)
	Pelobatrachus stejnegeri (Taylor, 1920)	*LC		(Site 1, 2 and 3)
Racophoridae	*Philautus surdus* (Peters, 1863)	*LC		(Site 2)
	Philautus acutirostris (Peters, 1867)	*LC		(Site 2)
	Philautus worcesteri (Stejneger, 1905)	*LC		(Site 1 and 2)
	Nyctixalus spinosus (Taylor, 1920)	*LC		
	Rhacophorus pardalis Günther, 1858	+LC		
	Leptomantis bimaculatus Peters, 1867	*LC		
	Polypedates leucomystax (Gravenhorst, 1829)	+LC		(Site 3)
Ranidae	*Staurois natator* (Günther, 1858)	*LC		
	Pulchrana grandocula (Taylor, 1920)	*LC		(Site 3)
	Sanguirana everetti (Boulenger, 1882)	*NT		
	Hylarana erythraea (Schlegel, 1837)	#LC		

Conservation status follows IUCN Red List of Threatened species (IUCN 2022).
*: Endemic; +: Native; #: Exotic; LC – Least Concern; NT – Near Threatened

This rapid assessment is the first account of the anurans in the Panigan-Tamugan watershed. This augments information about anurans in watersheds in the country. The data can also be utilized in the future to assess watershed health. More data can be generated by increasing the number of sampling days, surveying more transects, and including more sites; thus, increasing sampling effort and man hours in general.

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Conflict of interest

All authors declare that there are no conflicting issues related to this short communication.

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