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Unveiling Hidden Ranges: New Localities and Elevational Limits of Leyte Wart Frog, *Limnonectes leytensis* Boettger, 1893

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Abstract

The Leyte wart frog (*Limnonectes leytensis* Boettger, 1893) is an endemic anuran of the Philippines with a distribution that spans several islands in the central and southern regions of the archipelago. Despite its wide geographic occurrence, the full extent of its range remains incompletely documented, particularly in isolated and understudied islands. This study reassesses the species' distribution through extensive field surveys across 18 islands and examination of preserved museum specimens from the Senckenberg Museum-Frankfurt. A total of 282 individuals were recorded from nine islands, with new locality records from Siargao Island and a significant elevational extension at 1,300 meters above sea level in Gingoog City, Mindanao—the highest known record for the species. Conversely, the absence of *L. leytensis* from Leyte Island, its type locality, along with other historically documented sites such as Negros and Samar, raises concerns over potential local extirpations or misidentified historical records. Examination of museum specimens also confirmed previously unpublished occurrences in Masbate, Basilan, and Tawi-Tawi, thereby expanding the species' biogeographic context. The observed female-biased sex ratio and population variability across islands underscore the need for targeted conservation action. These findings contribute significantly to the understanding of the ecological range, biogeographic affiliations, and conservation needs of this widespread but understudied Philippine amphibian.

Keywords: Amphibian, Biodiversity, Herpetofauna, Island Biogeography, Species Diversity

1. Introduction

Philippines is an archipelago of more than7,610 islands [1] that host a considerable high number of endemic anurans[2] which is one of the richest in the world [3]. The country is recognized as one of the most important centers for herpetofaunal diversity and endemism in Southeast Asia [4]. Comprehensive amphibian diversity studies were conducted in some of the islands to provide an estimate of the

population, diversity, and distribution of Philippine amphibians from the northern reaches [5] to the southern end, particularly on the island of Mindanao[6].

The genus *Limnonectes* belongs to a family of fork-tongue frogs, and is a species-rich clade [7,8] which is distributed from southeastern Aisa, southeastern China, the Ryukyu Islands of Japan, south and eastward to New Guinea including the Philippines[9]. The Leyte wart frog is one the 12 species of Philippine *Limnonectes*that defied the distributional model of the archipelago's prevailing biogeographical paradigm [5, 10, 11]. It is currently documented in 13 islands in central and southern Philippines covering three Pleistocene Aggregate Island Complexes (PAICs) but probably occurs more widely than these records particularly in areas between known areas [12].

This study aims to reassess and expand the known distribution and ecological range of the Leyte wart frog, *Limnonectes leytensis*, by addressing gaps in existing records and uncovering new locality data. Specifically, it seeks to:

1. Conduct field assessments in islands and localities previously included surveyed, as well as selected islands not covered by earlierdistribution studies, thereby expanding the biogeographic dataset and identifying new population strongholds and elevational range limits; and
2. Examine the Leyte wart frog voucher specimens deposited at the Senckenberg Museum-Frankfurt to integrate unpublished historical records into current distributional analyses.

2. Materials and Methods

Ethical Consideration

Before the conduct of the actual fieldwork, consent from the city and municipal local government units (LGUs) was requested, and permission was asked from tribal leaders in areas with indigenous communities. A Wildlife Gratuitous Permit for this study was issued by the Biodiversity Management Bureau of the Department of Environment and Natural Resources with permit number WGP-347. Also, during the actual sampling, coordination with the Barangay LGUs, local police stations, and military detachments was conducted. Local guides with experience in frog collection were requested from the barangay leaders and contact persons.

Sampling Site

The study sites covered a total of 18 islands in 27 barangays under eight cities, and 19 municipalities; 15 provinces; and eight administrative regions. On Luzon Island, the sampling site was established in the Municipality of Matnog, Sorsogon, the southernmost tip and gateway of the island to the Visayas. In the Romblon Group of Islands (RIG) of Region IV-B, the collection site was set up in the Municipality of San Jose on Carabao Island. In Western Visayas Region, the sampling areas included Boracay Island in Barangay Manuk-Manuk Municipality of Malay; in the municipalities of Lambunao and San Enrique, Aklan on Panay Island; and Negros Island which comprised the cities of Bago and Bacolod; and the towns of Don Salvador Benedicto, Murcia, and Sibulan. In Central Visayas, the sites included Cebu City on Cebu Island; San Francisco on Pacijan Island of the Camotes Group of Islands (CGI); Bohol Island which covered Tagbilaran City and the towns of Antequera, Garcia-Hernandez, and Jagna; Jao Island under the Municipality of Talibon, Bohol; and Lapinig Island of the Municipality of Carlos P. Garcia, Bohol. In Eastern Visayas Region, the sites were established in Catbalogan City, Samar; and Ormoc City, Leyte. In Northern Mindanao Region, the sites included the cities of Iligan and

Gingoog. In Caraga Region, the sites comprised Surigao City; General Luna on Siargao Island; and the Municipality of Tubajon on Dinagat Island.

Field Sampling

The amphibian survey was conducted using general methodologies [5, 13, 14, 15, 16] and standard sampling techniques [17]. Specimens were collected and preserved using standard procedures [5, 13, 14, 15, 18, 19] and as stated in the WGP.

Collections were done from 1700 to 1900 hours for auditory strip sampling while the visual survey encounter survey was carried out from 1900 to 2000 hours. The identification of the frog was based on Inger (1954) and other available materials. To aid in the identification, individuals were captured and 41 biometric measurements were taken using a standard digital vernier caliper to the nearest 0.1mm. The definition and acronyms of the morphometric measurements followed Watters et al (2016) except for the fang length which was based on McLeod (2018) and Emerson (2001). The frogs were photographed, marked, and released after the procedure.

Museum Voucher Specimen Evaluation

The preserved Leyte wart frogs deposited at the Senckenberg Museum-Frankfurt were carefully examined. In order to minimize damaged to the voucher specimens, frequent flushing of 70% was conducted. The examination was done in a well-ventilated laboratory bench to lessen health risk and at the same time minimize fire hazard. Face mask and latex gloves were also used while working with the specimens. Morphometric measurements were also taken using digital vernier caliper. Photographs were taken after measuring the 41 morphometric characters and were put back to the storage jars.

3. Results and Discussion

Field Assessment

A total of 282 individuals of the Leyte wart frog (*Limnonectes leytensis*) were recorded from nine of the 17 surveyed islands. The species was **absent** from Boracay, Jao, Lapinig, Leyte, Luzon, Negros, Samar, and Siquijor. However, it was observed in smaller islands such as Carabao, Camiguin, Dinagat, Pacijan, and Siargao, and in the larger islands of Bohol, Cebu, Mindanao, and Panay.

Surprisingly, no individuals were observed on Leyte Island—the type locality of the species—where the holotype (SMF 4931, formerly 1017.3a) was collected by Spanish malacologist Don Jose Florencio Quadras. The specimen was subsequently brought to the Senckenberg Museum in Frankfurt by Dr. Otto Franz Möllendorff and described by Dr. Oskar Boettger in 1893. Additionally, the species was not found in Samar.

Its absence from Luzon is unsurprising given the biogeographic barrier posed by the deep San Bernardino Strait, which likely prevented the frog's dispersal from the Visayas. In contrast, its absence from Siquijor may be explained by the island's long-standing isolation during Pleistocene sea level fluctuations, which limited colonization opportunities.

Of notable significance is the new distribution record of *L. leytensis* from Siargao Island, located within the Northeastern Mindanao Island Chain. Furthermore, the frog was observed at an elevation of 1,300 meters above sea level in Gingoog City, Misamis Oriental, representing the highest documented elevational record for the species to date.

Population abundance varied across islands. The species was particularly abundant in Dinagat, Siargao, and Gingoog City, while only a single individual was recorded each from Carabao and Cebu islands. In Bohol, the frog was detected only in high-elevation areas (~700 masl), and it was absent from coastal sites such as Garcia-Hernandez, Tagbilaran City, and the outlying islets of Jao (Talibon municipality) and Lapinig (President Carlos P. Garcia municipality). Notably, it was also absent from Antequera, an interior municipality of Bohol. No individuals were observed at any of the five sites surveyed on Negros Island, despite previous reports indicating the species' common occurrence in both natural and anthropogenic freshwater habitats [20, 21].

Sex-based observations revealed a greater number of females than males overall, with the highest number of females recorded on Siargao Island. This skewed sex ratio may reflect seasonal sampling biases, differential habitat use, or potential sex-based survival differences, particularly in disturbed or fragmented habitats. This finding raises conservation concerns, as an underrepresentation of males could affect population stability and reproductive success. While there is no established optimal female-to-male ratio in the literature for *L. leytensis*, it is important to note that males of this species exhibit parental care, guarding the eggs post-amplexus, highlighting their critical role in offspring survival.

Museum Specimen Examination

A total of 29 preserved *Limnonectes leytensis* specimens housed at the Senckenberg Museum in Frankfurt were examined. These specimens were collected from eight localities across seven islands. After excluding juveniles, 25 adult specimens were included in the analysis. Among these was the holotype (SMF 4931), collected from Burauen, Leyte.

The remaining specimens were primarily collected by Dr. Maren Gaulke during her herpetological fieldwork across Southeast Asia and the Philippines. Her 1988 expedition to Masbate yielded five specimens from Palanan (misspelled as "Panal")—SMF 74310 to 74314—although her primary target was the island's snake fauna [22]. Between 1991 and 1992, she surveyed the Sulu Archipelago, collecting five *L. leytensis* from Basilan (SMF 74797–74801) and ten individuals from Tawi-Tawi Island: specifically, from Barangay Magsaggaw, Municipality of Panglima Sugala (SMF 74902–74907), and Barangay Tarawakan, Municipality of Bongao (SMF 75183–75186). She also obtained three juveniles from nearby Sanga-Sanga Island (SMF 74849, 74912–74913).

Her final collection site was in Samar Island, where she obtained five adult specimens from Bagacay Mines, Hinabangan (SMF 75212–75216). Additionally, a single specimen (SMF 75005) was donated by Dr. Angel C. Alcala, collected in Barangay Banilad, Dumaguete City, in 1964.

Dr. Gaulke's collections provided compelling historical evidence for the presence of *L. leytensis* in previously undocumented locations. The presence of the species in Masbate supports the island's inclusion in the West Visayas Pleistocene Aggregate Island Complex (PAIC) or the Negros-Panay Faunal Region, as evidenced by the occurrence of other Visayan endemics such as the Visayan spotted deer [23] and Visayan warty pig [24].

Similarly, her collections from Sanga-Sanga and Tawi-Tawi support the species' presence in the Sulu Archipelago. These findings corroborate earlier records from major institutions including the Museum of Comparative Zoology (Harvard), the Field Museum (Chicago), the British Museum (London), and the Carnegie Museum of Natural History [25], reinforcing the broad historical range of *L. leytensis*.

4. Conclusion

This study presents a comprehensive assessment of the current distribution and museum-confirmed historical records of the Leyte wart frog, *Limnonectes leytensis*, across central and southern Philippine islands. Field surveys revealed the species' persistence in both large and small islands, including new locality records such as Siargao Island and its highest known elevational range at 1,300 masl in Gingoog City, Mindanao. Notably, *L. leytensis* was absent from several historically known or expected areas such as Leyte Island—the type locality—Negros, and Samar, raising important questions about population decline, local extirpation, or historical misidentifications.

The rediscovery of the species in museum collections from underreported islands such as Masbate, Basilan, and Tawi-Tawi highlights the crucial role of historical specimen archives in uncovering overlooked distributional patterns. These findings reinforce the biogeographic affiliations of *L. leytensis* with multiple faunal regions, including the West Visayas PAIC and Sulu Archipelago, thereby expanding our understanding of its ecological amplitude and historical dispersal.

The observed female-biased sex ratio and island-specific variation in abundance suggest that localized environmental pressures and reproductive behaviors may influence population structure. Together, these findings emphasize the urgent need for continued field monitoring, population viability assessments, and targeted conservation strategies to preserve this species across its fragmented and changing island habitats.

5. Conflict of Interest

The author declares no conflict of interest. This research was conducted independently, and no external entity influenced the design, execution, interpretation, or reporting of the findings.

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7. Authors' Biography

Elvin Reyes Sansona is a Ph.D. Biology candidate at the Mindanao State University – Iligan Institute of Technology (MSU-IIT), currently conducting research on amphibian taxonomy, biogeography, and species distribution in the Philippines.

8. References

1. Kinser, J., "3D Elevation Data and Decision Support Systems for Developing Nations: Philippines", Philippine NSDI Case Study, 2020.
2. Diesmos, A.C., et al., "Amphibians of the Philippines, Part I: Checklist of the Species", Proceedings of the California Academy of Sciences, 2015, 62, 457–539.
3. Gojo Cruz, P.H.P., et al., "Distribution and Diversity Patterns of Herpetofauna in the Pantabangan-Carranglan Watershed, Nueva Ecija, Caraballo Mountain Range, Philippines", Biodiversity Data Journal, 2019, 7, e31638.
4. Diesmos, A.C., et al., "Amphibians and Reptiles", in Ong, P.S., et al. (Eds.), Philippine Biodiversity Conservation Priorities, DENR-PAWB, CI Philippines, UP-CIDS, FPE, 2002.
5. Brown, R.M., et al., "Evolutionary Process of Diversification in a Model Island Archipelago", Annual Review of Ecology, Evolution and Systematics, 2013, 44, 411–435. doi:10.1146/annurev-ecolsyst-110411-160323.
6. Siler, C.D., et al., "A New Species of Fanged Frog (Dicroglossidae: Genus Limnonectes) from Southern Mindanao Island, Philippines", Herpetologica, 2009, 65, 105–114.
7. McLeod, D.S., "A New Species of Big-headed Fanged Dicroglossine Frog (Genus Limnonectes) from Thailand", Zootaxa, 2008, 1807, 26–46.
8. Evans, B.J., et al., "Phylogenetics of Fanged Frogs: Testing Biogeographical Hypotheses at the Interface of the Asian and Australian Faunal Zone", Systematic Biology, 2003, 52, 794–819.
9. Frost, D.R., "Amphibian Species of the World: an Online Reference. Version 6.2", American Museum of Natural History, New York, 2024. Accessible at: https://amphibiansoftheworld.amnh.org/index.php (Accessed 25 January 2025).
10. Voris, H.K., "Maps of Pleistocene Sea Levels in Southeast Asia: Shorelines, River Systems, Time Durations", Journal of Biogeography, 2000, 27, 1153–1167.
11. Brown, R.M., Diesmos, A.C., "Philippines, Biology", in Gillespie, R., Clague, D. (Eds.), Encyclopedia of Islands, University of California Press, Berkeley, 2009, pp. 723–732.
12. IUCN SSC Amphibian Specialist Group, "Limnonectes leytensis", The IUCN Red List of Threatened Species, 2019, e.T41231A114914662. https://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T412331. (Accessed 25 January 2025).
13. Brown, R.M., et al., "The Philippine Frogs of the Genus Leptobrachium (Anura: Megophryidae): Phylogeny-based Species Delimitation, Taxonomic Revision, and Descriptions of Three New Species", Herpetological Monographs, 2009, 23, 1–44.
14. Brown, R.M., et al., "Phylogeography and Historical Demography of Polypedates leucomystax in the Islands of Indonesia and Philippines: Evidence for Recent Human-mediated Range Expansion?", Molecular Phylogenetics and Evolution, 2010, 57, 598–619.
15. Siler, C.D., et al., "Amphibians and Reptiles, Romblon Island Group, Central Philippines: Comprehensive Herpetofaunal Inventory", Check List, 2012, 8(3), 443–462.
16. Siler, C.D., et al., "Phylogeny-based Species Delimitation in Philippine Slender Skinks...", Herpetological Monographs, 2012, 26, 135–172.
17. Heyer, W.R., et al., "Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians", Smithsonian Institution Press, Washington, 1994.
18. American Society of Ichthyologists and Herpetologists (ASIH), "Guidelines for Use of Live Amphibians and Reptiles...", Lawrence, KS, 2004.

19. Simmons, J.E., "Herpetological Collecting and Collections Management", Herpetological Circular 42, SSAR, 2015, 1–210.
20. Alcala, A.C., "Guide to Philippine Flora and Fauna, Volume X: Amphibians and Reptiles", NRM Center & UP, Manila, 1986.
21. Alcala, A.C., Brown, W.C., "Philippine Amphibians: An Illustrated Field Guide", Bookmark Press, Makati City, 1998, 116 pp.
22. Gaulke, M., Altenbach, A.V., "Contribution to the Knowledge of the Snake Fauna of Masbate (Philippines)", Herpetozoa, 1994, 7(1/2), 63–66.
23. Brook, S.M., "Rusa alfredi", The IUCN Red List of Threatened Species, 2016. (Accessed 05 March 2025).
24. Oliver, W.L.R., "The Taxonomy, Distribution, and Status of Philippine Wild Pigs", Ibex, Journal of Mountain Ecology, 1995, 3, 26–32.
25. Inger, R.F., "Systematics and Zoogeography of Philippine Amphibia", Fieldiana: Zoology, 1954, 33(4), Chicago Natural History Museum.