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Population Assessment of Sulawesi's Endangered Snoring Rails (*Aramidopsis plateni*) in Gandang Dewata National Park

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Abstract. This study focuses on assessing the critically endangered mandar dengkur, or snoring rails (*Aramidopsis plateni* Blasius 1886), within Indonesia's Gandang Dewata National Park. Despite its importance in regional biodiversity, the species remains poorly documented. The primary objectives of this research are to investigate the population and ecological role of the mandar dengkur in Gandang Dewata National Park. It aims to understand their population status, the factors influencing their survival, and the level of global threats facing this species. Field surveys from July to August 2023 employed point counts and interviews with local residents, revealing a population of 20 snoring rails. Tondok Bakaru was identified as the primary subpopulation, with the highest count and probability of occurrence. Tondok Bakaru, characterized by remote and isolated areas, plays a crucial role in snoring rails' survival, mirrored by discoveries of other sensitive species like the Anoa. Environmental variables analysis through Generalized Linear Modeling (GLM) identified the nearest food source and settlement as significant factors influencing snoring rail populations, aligning with their elusive nature. The selected GLM model highlighted the impact of average NDVI, distance to the nearest food source, and distance to the nearest settlement on snoring rail density, guiding conservation efforts. This study underscores the urgency of upgrade the snoring rails' conservation status to Endangered (EN) and implementing global conservation measures by improving data collection with technology.

Keywords: Gandang Dewata National Park; snoring rails; population assessment; conservation efforts.

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INTRODUCTION

Gandang Dewata National Park, situated on the island of Sulawesi, Indonesia, boasts a rich diversity of unique and valuable plant and animal species. Among the noteworthy flora within the park, the ebony trees stand out as a prime example of this unique and invaluable plant life (Karlinasari et al. 2021). These ebony trees are not only exceptional but are also endemic to Sulawesi.

In addition to the remarkable plant life, the park is also home to a range of endemic fauna, from megafauna such as the Anoa (*Bubalus* sp.) to smaller mammals like the Sulawesi endemic shrew species, *Crocidura elongata*. Recent observations have indicated a notable presence of the Anoa within Gandang Dewata National Park, establishing it as a region with a high habitat probability for these remarkable creatures (Ardiani et al. 2022). Furthermore, research findings reveal that Mt. Gandangdewata, a part of Gandang Dewata National Park, has the Sulawesi endemic shrew that exhibits genetically distinct populations along a single elevational gradient, spanning from 170 meters to 1535-1600 meters, and finally, to 2200-2600 meters (Eldridge et al. 2018). While these endemic mammals are of significant interest, one species that garners particular concern is the mandar dengkur, more commonly known as "The snoring rails." The presence of the snoring rails in Sulawesi serves as a pivotal example of regional biodiversity,

shedding light on the grave challenges faced by endemic species worldwide.

The snoring rails, scientifically known as *Aramidopsis plateni*, are a rare and endangered species, restricted to a few specific locations within Sulawesi. These remarkable birds have been protected by Indonesian law since 1990 and continue to be protected under Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor P.106/MENLKH/SETJEN/KUM.1/6/2018. Their conservation status is further underscored by their Vulnerable classification in the IUCN Red List Category (BirdLife International 2016), under Criteria C2a(i), owing to their limited knowledge and presumed small population.

Recent sightings of the snoring rails have been recorded in Bogani Nani Wartabone National Park, Nantu in Gorontalo, and along the Menado River, south of Tondano. Notably elusive and shy, these birds are typically found in both primary and secondary forests at elevations below 1300 meters above sea level. Despite their conservation status and the challenges of assessing their population, some researchers have suggested categorizing them under the genus Lewinia, citing their extensive spatial and ecological range (Eaton et al. 2022). However, despite their importance, limited information is available regarding the ecological role of the snoring rails (Gaspar et al. 2020), particularly within Gandang Dewata National Park. Remarkably, there is no documented record of this species within the park, even though the park was established in 2016, reflecting the government's commitment to expanding its protected area network (Pusparini et al. 2023). Gandang Dewata National Park, strategically connected to Lore Lindu National Park, has been earmarked to play a pivotal role in the central Sulawesi corridor, adjacent to the extension from Pegunungan Tokalekaju.

This research focuses on the presence of the snoring rails within Gandang Dewata National Park, recognizing the critical importance of their conservation in preserving the biodiversity of the local ecosystem and contributing to global conservation efforts. This research aims to investigate the population and ecological role of the mandar dengkur in Gandang Dewata National Park, with the primary objectives of understanding their population status, the factors influencing their survival, and the level of global threats facing this species. The knowledge gained from this research will provide a solid foundation for the development of more effective conservation strategies. Furthermore, this research will also discuss the contributions of mandar dengkur to the Gandang Dewata National Park ecosystem and their role in maintaining ecological balance in this region.

METHODS

This research employed field survey methods to assess the population of the Sulawesi endemic bird species, the mandar dengkur (*Aramidopsis plateni*). Samples were systematically collected from various habitats within Gandang Dewata National Park through four villages in Mamasa district: Taupe, Tondok Bakaru, Mambuliling, and Rambusaratu (Figure 1). We conducted field surveys from July 2023 to August 2023.

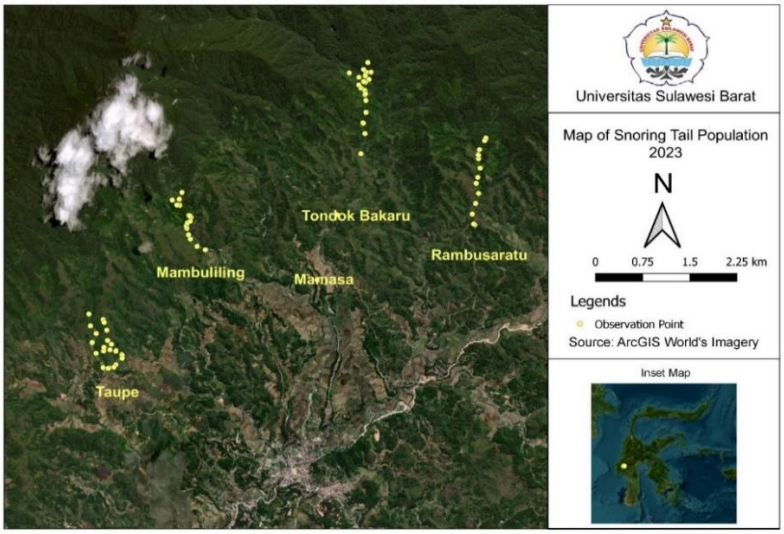

Figure 1. Map of snoring tail population in Gandang Dewata National Park.

The population data sampling method utilized in this study was the point count method, using compass direction to track the movement of the birds and avoid double counting (Golding et al. 2018, Putera et al. 2021), where each observation point had a 50-meter radius (Figure 2). Samples were taken from within the 50-meter radius, with each observation lasting 15 minutes, conducted between 06:00 AM to 09:00 AM local time, and with a 200-meter spacing between observation points. Each observation route consisted of 5 observation points, totaling 50 observation points across 10 observation routes.

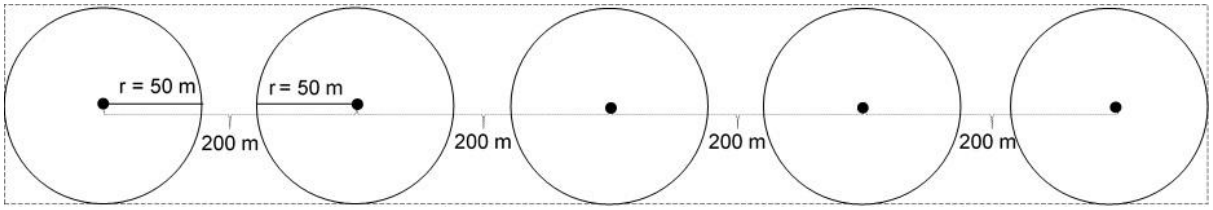

Figure 2. Point Count method for mandar dengkur population data Ssampling

These observation routes were evenly distributed across various ecosystems housing mandar dengkur habitats, taking into consideration their respective elevations. Mandar dengkur habitats encompassed lowland tropical rainforests, mountainous tropical rainforests, tropical highlands, and tropical rainforests, with elevations ranging from approximately 0 to 1000 meters above sea level (BirdLife International 2016). Reference from BirdLife International (2016) was adjusted to match the ecosystem type, habitat, and elevation information found in the South Sulawesi Natural Resources Conservation Agency (Balai Besar KSDA Sulawesi Selatan), which operated within the West Sulawesi region.

Additionally, information regarding the presence of mandar dengkur birds was obtained through interviews with local residents residing in the vicinity of Gandang Dewata National Park (Figure 3). The interview questions inquired whether the interviewers had encountered the mandar dengkur bird species (accompanied by a picture of the mandar dengkur bird) and the location of these sightings.

During the counting of individual birds at each observation point, a minimum of two observers was required (Crossland et al. 2023), and the results were standardized by calculating the average number of individuals at each observation point to prevent human errors during the counting process (Loosen et al. 2022). The equipment used during observations consisted of one Nikon Aculon A211 12x50 binoculars and one Bushnell 16x52 monocular, a field identification guide titled "Birds of the Sunda Shelf and Wallacea Islands in Indonesia," one blank tally sheet along with its pad at each observation route for recording observation results, and writing tools (ballpoint pens, rulers, pencils, erasers).

To process population data, the initial calculation of population size (Rahman 2021) based on point count method (Crosby et al. 2019, Sólymos et al. 2020) was performed by dividing the area of the observation route (A), which was studied (measuring 900 meters in length × 50 meters in width), by the area of the sample unit (a) represented as circular observation points (with a radius of 50 meters). The initial calculation of the sample unit's population size (N) was determined using the following equation:

$$N = A / a$$

The result of this calculation, which was the population size (N), was then multiplied by the average individual density of each sample unit/observation point ($\bar{x}$), thereby yielding the estimated total population across all observation routes. The calculation was conducted using Microsoft Excel 2013. The calculation for the estimated total population (P) in the TNGD area was expressed using the following equation:

$$P = N.\bar{x}$$

Moreover, environmental variables were collected to be analyzed as ecological factors for the species' survival. There were 10 environment variables generally found as ecological factors in other species. The variables were Normalized Difference Vegetation Index (NDVI), elevation, average temperature, precipitation, wind speed, the nearest water source distance, the nearest food source distance (the foraging as marked objective for food source based on field observation), the nearest road, the nearest settlement, and primary dryland forest land cover. The sources of environment variables were Landsat 8 satellite

imagery in USGS Earth Explorer, WorldClim, ArcGIS World's Imagery, and Sentinel-2.

To get the values of environment variables, the downloaded satellite image was analyzed by the algorithm of Sample Raster Values from Raster Analysis feature in QGIS 3.16.14 Hannover version. After obtaining the values, the environment variables and the relative density of this species were analyzed through Generalized Linear Modelling (GLM) Framework. The first step was multicollinearity test through Variance Inflation Factor (VIF) to select the interdependent variables as low as possible. The second step was t-test to identify significant variables related to the relative density of the snoring rail. The third step was building the models by GLM. The fourth step was model selection by Akaike Information Criterion (AIC). This model selection chose the best model for the population ecology of the snoring rail. The fifth step was Deviance of Goodness of Fit Test to interpret the suitable and best model. The sixth step or last stage was visualization by ggplot2 package (Wickham 2016). All steps were implemented in the R Programming Language (R Core Team 2021).

RESULTS AND DISCUSSION

Results and Discussion

The result shows 20 individuals in the total population, and Tondok Bakaru becomes the highest subpopulation among others (Table 1). Tondok Bakaru has the highest probability of occurrence among other location. This location also estimate 2.864 equal to 3 individuals per unit of area (3 individuals per 7857.143 square meters). Followed by the second high subpopulation, Taupe has 0.764 equal to 1 individual per 7857.143 square meters. On the other hand, Rambusaratu has lower estimated total population and Mambuliling has no recorded individual during the field survey. This result is supported by the result of interview to the local people each location (Figure 3). The local people said that they never see this species on Mambuliling village. The habitat on Mambuliling might be not suitable for the snoring rail's population because the location is not really far from the settlement compared to other location.

Table 1. Population of The snoring rails on Gandang Dewata National Park through 4 villages

Population	Taupe	Tondok Bakaru	Mambuliling	Rambusaratu
The number of individuals	4	15	0	1
Sample unit's population size (N)	5.727	5.727	5.727	5.727
Estimated total population (P)	0.764	2.864	0	0.286
Probability of Occurrence	0.133	0.433	0	0.05
Percentage of Population (%)	13.33	43.33	0	5

Figure 3. Interviewing two local people on Mambuliling village, Gandang Dewata National Park.

Figure 4. Footprint of foraging activities from the snoring rail on Tondok Bakaru village

Otherwise, the Tondok Bakaru still has many spots with remote or isolated far from the settlement. The spots such as footprint (Figure 4) based on information from the experienced local guide and the wetland like shrubland (Figure 5) can be found on the route from Tondok Bakaru to the core of Gandang Dewata National Park. Not only many remote places for this rail, but also recent finding about other wildlife are found on the Tondok Bakaru according to the maps, for example Anoa (Ardiani et al. 2023, Jaelani et al. 2023). This finding show that the sensitive creature like Anoa cannot live with human disturbance so that the Anoa could be found on the remote places. Similar to the snoring rail as the sensitive creature, this rail might live only on the isolated location and far from human disturbance.

Figure 5. Wet shrubland habitat of the snoring rail found on the track of Gandang Dewata National Park.

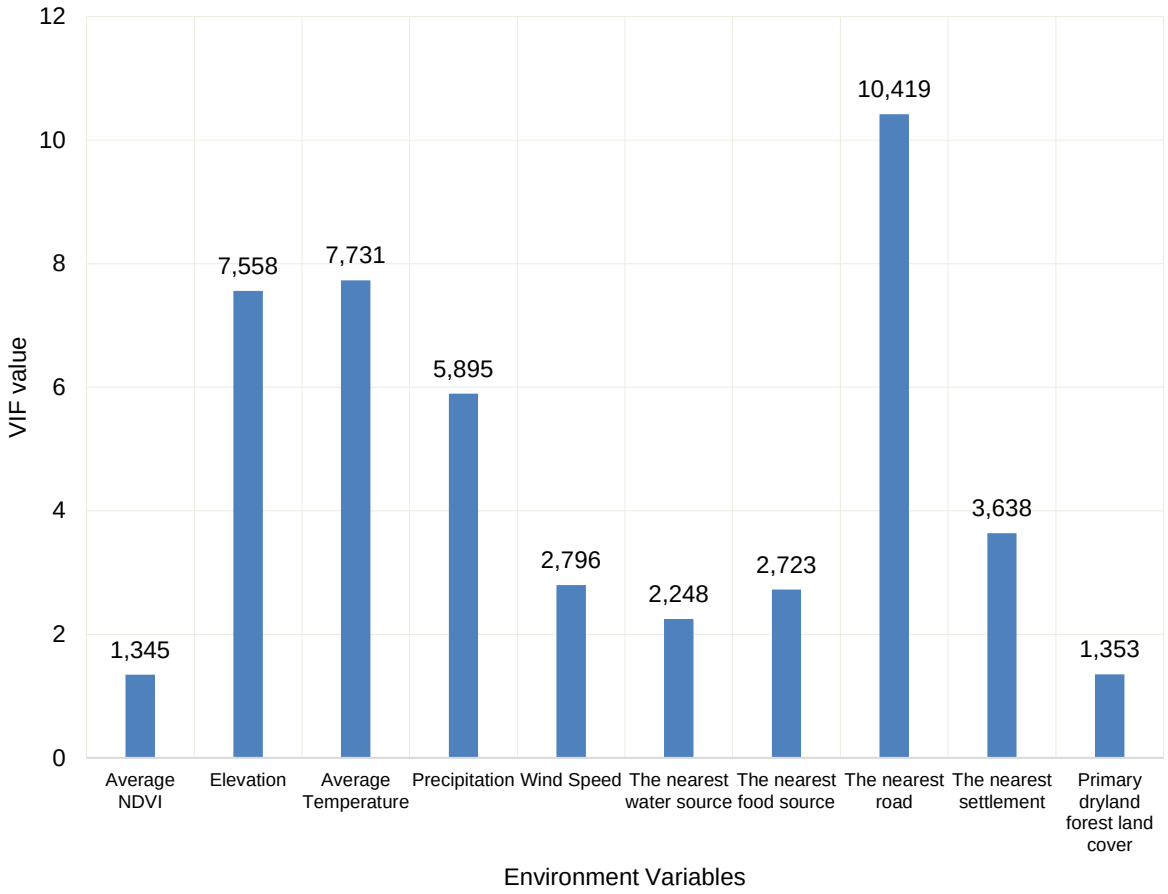

Figure 6. The multicolinearity test aims to eliminate variables with high Variance Inflation Factor (VIF) value (VIF > 5.00)

The multicolinearity test (Table 2) showed few environment variables has fairly high VIF value such as the nearest road, average temperature, elevation and precipitation. These variables could not be used for the following stages because the VIF values indicated dependency among these environment variables (Putera et al. 2021). Hudjimartsu et al. (2017) support that the VIF value more that ten is found on some variables, then the variables has clearly multicolinearity to other variables. Less trustworthy statistical inferences can arise when there is multicollinearity among independent variables (Daoud 2017). Therefore, these four variables were excluded to the environment variables.

Table 3. The t-test to find the ecological factor to the population of snoring rail

Environment Variables	Average NDVI	Wind Speed	The nearest water source	The nearest food source*	The nearest settlement*	Primary dryland forest land cover
t-test	0.355	0.944	0.392	0.007	0.006	0.665

*significant (p-value < 0.05)

The environment variables left six variable and two of the variables show significancy: the nearest food source and the nearest settlement (Table 3). This makes sense because the bird snoring rail has elusive and shy characteristic that makes this species forages food comfortably on the remote places. The food within their home range is located, while the remote places are far from the settlement. This relevant to other sensitives species like Anoa which prefers far from the crowds of human (Ardiani et al. 2023).

Table 4. The model selection based on Akaike Information Criterion (AIC) and AIC difference (ΔAIC)

Model	M01[a]	M02[b]	M03[c]	M04[d]	M05[e]	M06[f]
AIC	-556.506	-560.559	-561.215	-563.109	-565.108	-565.024
ΔAIC	8.602	4.549	3.893	2.001	0	0.084

[a]NDVI+Elevation+Average Temperature+Precipitation+Wind Speed+The nearest water source+The nearest food source+The nearest road+The nearest settlement+Primary dryland forest land cover from 2020 to 2023
[b]NDVI+Elevation+Average Temperature+Precipitation+Wind Speed+The nearest water source+The nearest food source+The nearest road+The nearest settlement+Primary dryland forest land cover from 2022 to 2023
[c]Average NDVI+ Wind Speed+ The nearest food source +The nearest settlement+Average primary dryland forest land cover
[d]Average NDVI+Wind Speed+The nearest food source +The nearest settlement
[e]Average NDVI+The nearest food source +The nearest settlement
[f]The nearest food source +The nearest settlement

Akaike Information Criterion (AIC) inform the two model M05 and M06 can be chosen as the selected model (Table 4). In the model selection, the lowest AIC differences at 0 show high support rather than AIC differences more than 1. The lowest AIC differences, the highest support for the best and fittest model (Dunn et al. 2018). According to the lowest AIC differences, M05 and M06 can be selected on the next stages to get the most valuable model for the snoring rail's population.

Table 5. The fittest and best model for snoring rail's population

Model		**M05**		**M06**	
Environment variables	Average NDVI	The nearest food source*	The nearest settlement*	The nearest food source*	The nearest settlement*
GLM	0.158	$3.55x10^{-3}$	$3.26x10^{-3}$	$3.309x10^{-3}$	$9.87x10^{-4}$
Fit test	0.155	$2.795x10^{-3}$	$2.545x10^{-3}$	$2.595x10^{-3}$	$6.794x10^{-4}$

*significant (p-value < 0.05)

The result of GLM and Fit test showed that there is no drastically changed on the M05 rather than M06 (Table 5). This consistency of result brings the M05 to keep two factors: the nearest food source and the nearest settlement with little changing, instead of M06. GLM has produced successfully the fittest and best model below equation (Figure 5):

$$y = 4.795x10\text{-}2x_1 – 1.407x10\text{-}5x_2 + 3.586x10\text{-}6x_3 – e$$

with y denoted as indiviual density, x_1 denoted as average NDVI, x_2 denoted as the nearest food source, x_3 denoted as the nearest settlement, and e denoted as error approximately $9.01x10^{-3}$. A negative mark (–) on the nearest food source means the shorter distance between the species and the food source. A positive mark (+) on the nearest settlement informs the longer distance between the species and the human disturbance, while the similar mark on average NDVI shows the greener location of the observed snoring rail individual. The vegetation which is greener indicated to be used by this species for their daily activities (Fontúrbel et al. 2021), for instances, foraging, looking for a potentially nesting sites, and exploring their home range. The greater the distance between the human settlement and the species, the better it serves as a refuge for some individuals seeking protection from human disturbance. The shorter the distance between the food source and the species, the higher the number of individuals that forage for food.

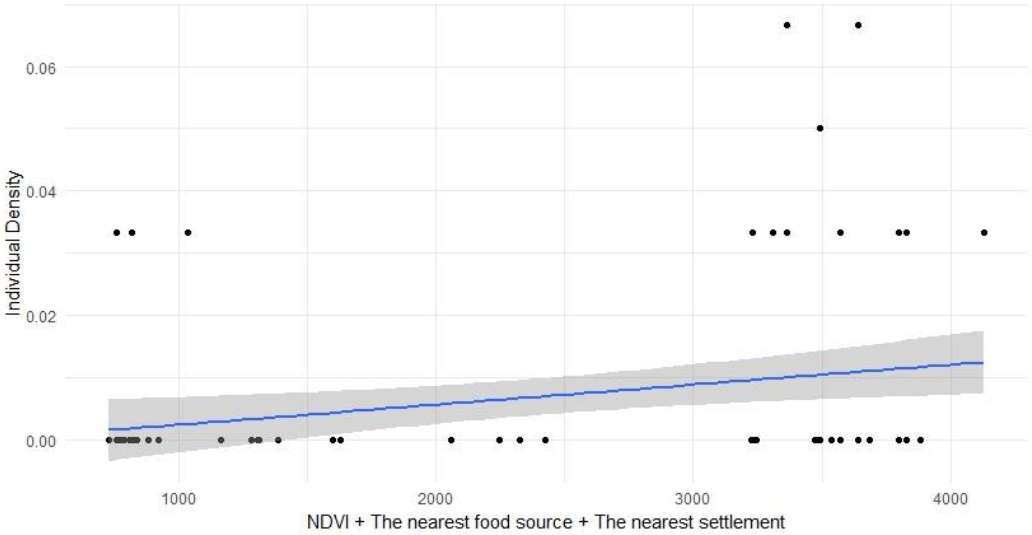

Figure 6. The fittest and best model representating individual density affected by the ecological factors such as NDVI, the nearest food sources and the nearest settlement on the Gandang Dewata National Park.

The results indicate an urgent need for conservation planning and action to prevent the extinction of this endemic species. The small populations in the four villages of Taupe, Tondok Bakaru, Mambuliling, and Rambusaratu reflect a conservation status classified as Vulnerable by the IUCN Red List since 2016, and without further assessment, this status could deteriorate to Endangered. The reliability of the literature for population assessment is poor (Berryman et al. 2023), especially concerning species with minimal information, such as the snoring rail. The population of endemic species will also bring new information about the distribution (Zulkarnaen et al. 2022). Consequently, there is a necessity for enhanced fieldwork and data collection methods in future surveys to address the least information about the population and distribution. The currently collected data is insufficient; it could be significantly improved with modern technologies like camera video traps (Fontúrbel et al. 2020, Abrha et al. 2023), bioacoustic recorders (Frommolt et al. 2014, Abraham et al. 2020), or thermal drones (Santangeli et al. 2020, Howell et al. 2021). The application of these technologies could yield better results, thereby strengthening conservation efforts for the snoring rail in Gandang Dewata National Park.

CONCLUSION

The population status of the snoring rail in Gandang Dewata National Park, aimed at understanding their numbers, reveals a very small population, with only 20 individuals counted within the park. The highest to lowest subpopulation are from Tondok Bakaru, Taupe, followed by Rambusaratu dan Mambuliling. The factors influencing the survival of snoring rail's population are the nearest food source and the nearest settlement. Therefore, this result could encourage the conversation status to be more concern as Endangered (EN) category so that prioritize for conservation action from local to global can be implemented altogether from all around the world, saving this elusive and poorly known species from the extinction on the future. The results of this research are expected to provide valuable insights into the importance of preserving endemic species and protecting their habitats in Sulawesi and similar regions worldwide. In this context, this research not only makes a significant contribution to local environmental conservation but also offers broader insights into the importance of sustaining wildlife and ecosystems on our increasingly threatened planet.

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