

## Short Communications

# Notes on The Current Distribution and Abundance of The Frog Genus *Leptophryne* spp. (Anura: Bufonidae) in Gede Pangrango National Park

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### ABSTRACT

We reported the current distribution of *Leptophryne* spp. in Gede Pangrango National Park. *Leptophryne cruentata* was recorded in Cibodas (Cikundul waterfall and Goa Lalay), Selabintana (Cibeureum Waterfall), and Goalpara (Rasta Waterfall), whereas *Leptophryne borbonica* was only reported from a creek at lowland forest of Bodogol. Goa Lalay and Rasta waterfall were explicitly reported as new distribution locations of *Leptophryne cruentata*. It was strictly found at a higher elevation usually within reach of waterfalls that generate substantial background noise, except in Cibodas in which *Leptophryne cruentata* can also be found in two noisy creeks located at a fairly great distance from waterfalls (100 – 170 meters).

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Gede Pangrango National Park (GPNP) is an important area in providing resources and shelters for many endemic and rare species. The very few unchanging features of this park over decades help sustaining a huge number of important species by providing them a lot of resources and tranquillity of habitats. *Leptophryne cruentata* is one of the endemic frogs of Java, Indonesia. This frog currently reported only presents in West Java following the recent study that split this cryptic species into two different species (Hamidy et al. 2018). *Leptophryne cruentata* is the only amphibian species listed in protected species in Indonesia. Due to small area of distribution and significant increase of population during decades, this species categorised as Critically Endangered in red lists of IUCN. Its distribution in West Java has been documented in Gede Pangrango, Halimun Salak, and Ujung Kulon (Kurniati 2002; Kurniati 2006), but its population is more prolific in Gunung Gede National Park (Mumpuni 2001; Kusrini et al. 2017), thus, encouraging conservation efforts in this area is more principle. One of the conservation actions required to be addressed is updating the population of *Leptophryne cruentata* and identifying the novel distribution of this frog in GPNP (Iskandar & Erdelen 2006; Kusrini et al. 2007b; Kusrini et al. 2017; Saputro et al. 2021).

The distribution of this frog in this GPNP could probably be more widespread which is indicated by newly anecdotal areas reported being occupied by *Leptophryne cruentata*. The possibility of discovering this frog in other locations in GPNP is also promising because there are so many areas in GPNP considered to be potential habitats for *Leptophryne cruentata* (Saputro et al. 2021). Moreover, additional information on habitat features, such as elevation and noise, are pivotal to be addressed since *Leptophryne cruentata* are strongly associated with waterfalls and high elevation (Iskandar & Erdelen 2006; Kusrini et al. 2007a).

In addition to *Leptophryne cruentata*, GPNP is also a habitat for its sister species, namely *Leptophryne borbonica*. *Leptophryne borbonica* is not an endemic frog and is not listed as species that requires a greater concern on its distribution and population as its widespread distribution and relatively high in number (Inger & Stuebing 1997; Iskandar 1998; Malkmus 2002; Ardiansyah et al. 2014).

Thus, the occurrence of *Leptophryne borbonica* in this park has been neglected for decades, based on our knowledge, their distribution is only documented in Bodogol (Ardiansyah et al. 2014) and Cibereum (Cibodas) (Kusrini et al. 2017). Therefore, a study that investigates and updates the information on this frog is necessary.

In this study, we aimed to explore various areas in GPNP that are potentially utilised by *L. cruentata* and *Leptophryne borbonica*. We also aimed to address niche segregation between two frog species based on data on their distribution as well as incorporated several habitat parameters that likely has a strong functional link with their distribution and abundance.

The study was conducted in August – December 2022 at 11 sites in GPNP (Figure 1). We performed consecutive surveys at Cibodas, Selabintana, Goalpara, and Bodogol. We visited 5 locations in the Resort of Cibodas, 3 locations in the Resort of Selabintana, and 1 location in the Resort of Goalpara. All locations surveyed in this study were presented in Table 1 including resort information and the type of water body.

We conducted daily and nightly observations using visual encounter surveys to record the presence of *Leptophryne cruentata* and *Leptophryne borbonica* in 11 locations (Table 1). Daily observations were used exclusively to record the presence of *Leptophryne cruentata* since this frog is active and easily captured during the day. We performed daily observations between 08.00 – 12.00. Night observations were conducted between 19.00 – 23.00 to detect the presence of *Leptophryne bor-*

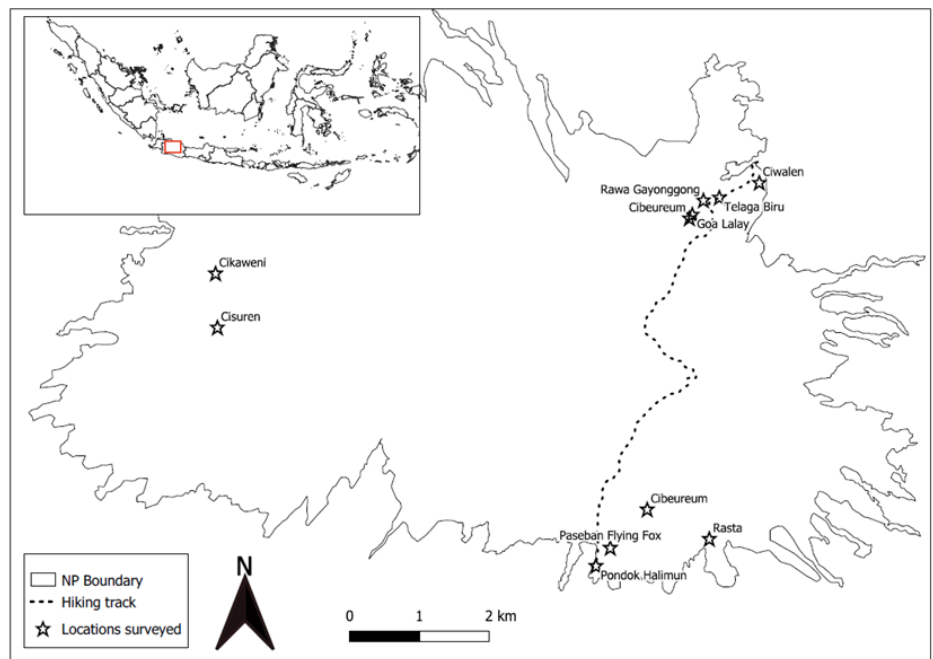
**Table 1.** Eleven sites surveyed in this study for the presence and abundance of *Leptophryne* spp. Information on the type of water bodies from all sites was also recorded.

No	Sites	Resort	Type of water bodies	Elevation zone
1	Ciwalen	Cibodas	Creek	Submontane
2	Telaga Biru	Cibodas	Creek	Montane
3	Rawa Gayonggong	Cibodas	Creek	Montane
4	Goa Lalay	Cibodas	Creek	Montane
5	Cibeureum	Cibodas	Waterfall	Montane
6	Pondok Halimun	Selabintana	Stream	Submontane
7	Paseban Flying Fox	Selabintana	Stream	Submontane
8	Cibeureum	Selabintana	Waterfall	Montane
9	Rasta	Goalpara	Waterfall	Submontane
10	Cisuren	Bodogol	Creek	Lowland
11	Cikaweni	Bodogol	Creek	Lowland

*bonica*. We performed 3 – 5 visits for each location to ensure the validity of detection.

We estimated the abundance of each species of *Leptophryne* spp. based on one day/night calculation by investigating exhaustively all the individuals obtained in each sampling location. Since both species of frogs are territorial and rarely change their position for several hours, we can ascertain that the probability of individuals being resampled was negligible. We marked the location of all recorded individuals using GPS. We also measured the level of background noise for each location by placing Extech 407736 Digital Sound Level Metre in the centre of each location. We extracted altitude information on each individual location from Digital Elevation Model provided by Shuttle Radar Topographical Mission (SRTM) in USGS. Annual temperature and precipitation were collected by analysing raster images captured in 2018 from Bioclim (<https://www.worldclim.org/data/bioclim.html>).

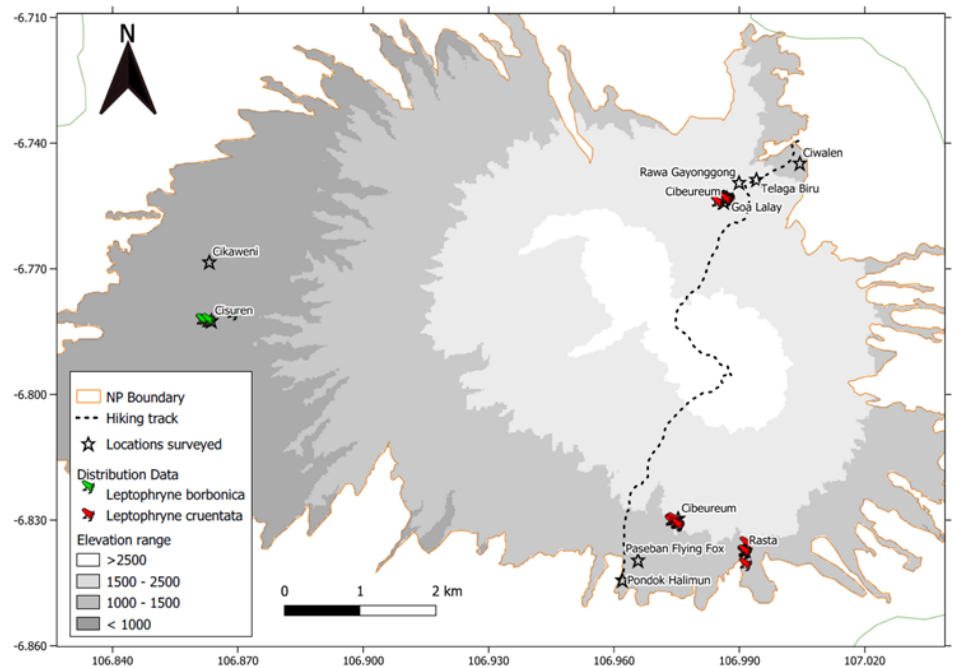
We used QGIS version 3.18.2 to visualise the distribution of both frogs on a 2D map of Gede Pangrango National Park. Digital Elevation Model (DEM) was classified into 4 categories following [Kusrini et al. \(2017\)](#) using Raster Calculator Tool in QGIS to easily visualise the distribution of the frogs in four different zones in GPNP (alpine, montane, sub-montane, and lowland forest). We also provided statistical comparisons of occurrence site parameters (elevation, annual temperature, annual precipitation, and background noise level) by generating 95% confidence intervals, based on 1000 bootstrapped estimates, around median values. Analysis was performed using R version 4.2.2 (R Project for Statistical Computing, <http://www.R-project.org>).



**Figure 1.** Map of 11 locations visited in this study indicated by stars. Locations covered the montane, sub-montane, and lowland forest of Gede Pangrango National Park.

Distributional records of *Leptophryne cruentata* in GPNP were relatively more widespread than its sister species. *Leptophryne cruentata* was documented in 4 of 11 locations visited during a course of study (Figure 2). We recorded the presence of *Leptophryne cruentata* on Cibodas trail scattered at three different sites, Cikundul waterfall, a creek near Cibeuureum, and Goa Lalay. Within the Selabintana and Goalpara resorts,

*Leptophryne cruentata* was only recorded in one location respectively, Cibereum waterfall and Rasta waterfall. The number of individuals was slightly greater in Cibodas (N=23) relative to Goalpara (N=11) and Selabintana (N=9) respectively. In Goalpara and Salabintana, *Leptophryne cruentata* is exclusively found only within waterfall habitats (no more than a radius of 100m from waterfalls), whereas this frog in Cibodas was not only observed within reach of waterfalls but also documented in fast-slowing creeks at Goa Lalay (n=3) and Cibereum (n=15) which located far enough from waterfalls. *Leptophryne cruentata* tended to avoid Cibereum waterfall as shown by the absence of this frog in this location, the presence of *Leptophryne cruentata* was recognised in Cikundul waterfall (n=5) located just a few meters behind the Cibereum waterfall. We also observed variation in the coloration of *Leptophryne cruentata* in Cibodas (Figure 3). *Leptophryne borbonica* was obtained only at Cisuren, a slow-moving creek, in the lowland forest of bodogol. We did not record the presence of this frog in Cikaweni.

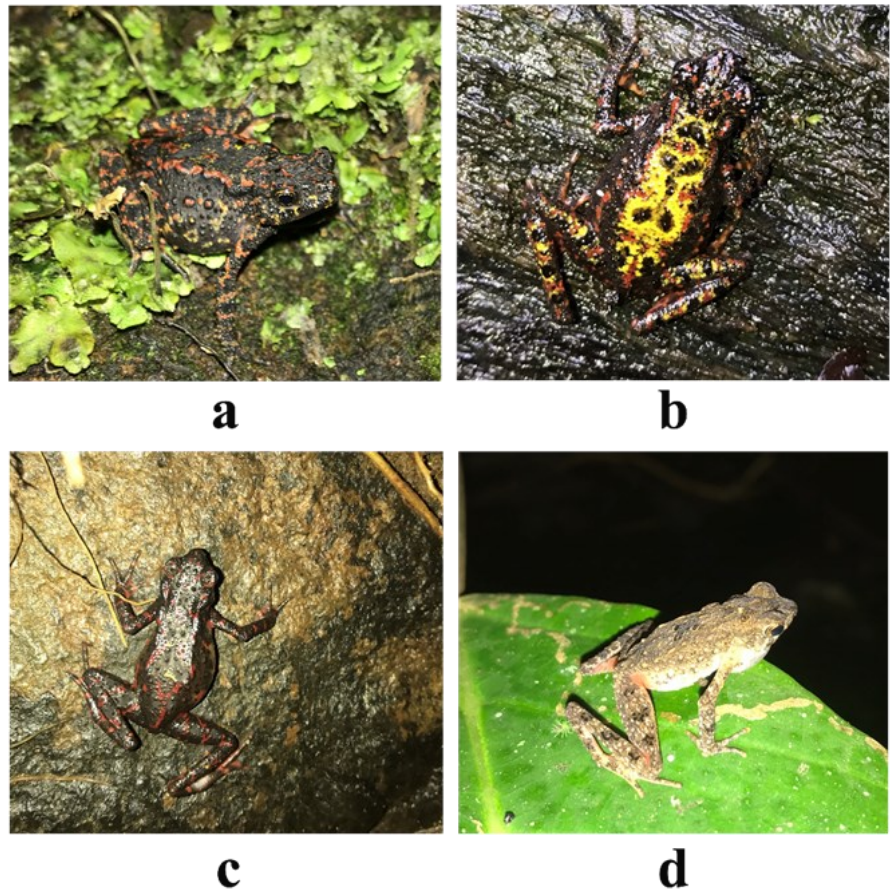


**Figure 2.** Distribution map of *Leptophryne* spp. showing that *Leptophryne cruentata* has a more widespread distribution than *Leptophryne borbonica*. *Leptophryne cruentata* also exhibits a high association with higher altitudes (montane and sub-montane zone), whereas *Leptophryne borbonica* occurred exclusively in lowland forests.

Information on the distribution of *Leptophryne cruentata* and *Leptophryne borbonica* had been rarely explicitly studied and usually concentrated only on small or specific areas, making the centre of conservation priorities inadequate. Yet, a recent study also reported the distributional changes of some species of frogs driven by many factors after 40 years (Kusrini et al. 2017), highlighting the importance of monitoring the distribution of frogs regularly. Focusing on *Leptophryne cruentata* we found even just only 10 years after (Kusrini et al. 2017), the distribution of this frog has changed. In our study, *Leptophryne cruentata* was reported in Cibereum and Goa Lalay and absent in Rawa Gayonggong. Distribution of this frog in Cibereum was documented in two sites, rapid creeks near the main waterfall and Cikundul waterfall.

In addition, we also recorded new distribution of this frog in Selabintana and Goalpara that had not been explicitly reported by pre-

vious studies (Liem 1971; Kusrini et al. 2017). Meanwhile, the occurrence of *Leptophryne borbonica* was recorded only in a slow-moving creek in the lowland forest Bodogol, namely Cisuren. Our finding demonstrated that the distribution of this frog has experienced substantial changes demonstrated by our failure to detect the occurrence of *Leptophryne borbonica* in Cikaweni (Bodogol) and Cibodas as these sites were previously reported as distributional sites of *Leptophryne borbonica* (Kusrini et al. 2007b; Ardiansyah et al. 2014). The lowland forest of Bodogol still retains its natural condition, but intense intrusion from the forest edge driven by man-made activities could probably force the frog to move to a higher elevation or cooler environment (Sulaeman et al. 2019; Erfanda et al. 2019; Muliani & Krisnawati 2022).



**Figure 3.** *Leptophryne cruentata* (a – c) and *Leptophryne borbonica* (d). Variation in coloration was shown in *Leptophryne cruentata* (a - b), some individuals of *Leptophryne cruentata* were observed adhering to vertical rocks in Goalpara waterfalls (c).

The absence of *Leptophryne cruentata* in Rawa Gayonggong reported in our study is probably linked to a low level of vegetation cover and the scant number of seepages. *Leptophryne cruentata* has been reported to prefer habitats that are facilitated with greater canopy cover (Saputro et al. 2021) and provided with an adequate number of flowing seepages or creeks. The association between *Leptophryne cruentata* and aqueous habitats has been previously studied and reported the absence of this frog in Lebak Saat due to the dryness condition in this location (Kusrini et al. 2017).

As seen on the map, both species did not exhibit niche overlap as indicated spatially by the different sites of distribution. The sites occupied by *Leptophryne cruentata* were not shared with *Leptophryne borbonica*.

Niche segregation was also explained by differences in the selection of elevation, annual precipitation, annual temperature, and noise as their habitats. *Leptophryne cruentata* inhabited highland forests with substantial noise backgrounds generated by waterfalls or fast-flowing creeks (Table 2). Even though both species showed a high preference for rocky creeks, *Leptophryne borbonica* tended to choose slow-flowing creeks with low to medium-level of noise backgrounds. In addition to the differences in site selection, both species also have different ways of foraging. *Leptophryne cruentata* can be obtained actively foraging and socialising during the day and night, whereas *Leptophryne borbonica* actively foraged only at night.

*Leptophryne cruentata* covered a wide range of distribution compared to *Leptophryne borbonica*. However, the occurrence of this frog is limited in the montane and submontane zones, none of *Leptophryne cruentata* was recorded in lowland forests as the only habitat for *Leptophryne borbonica*, based on our study. We did not perform observation on both species of frogs in the Alpine zone (Lebak Saat and Rawa Denok), thus, we cannot explain the distributional pattern of these frogs in a broader context. Despite Lebak Saat being known as a historical site for *Leptophryne cruentata*, however, the latest study confirmed the absence of this frog in this area (Iskandar & Erdelen 2006; Kusrini et al. 2017). The difference in niche selection between these two frog species is probably driven by the preference of both species for different environmental features. *Leptophryne cruentata* tend to prefer habitats at higher altitudes that facilitate a high level of moisture (Kusrini et al. 2007b). While its sister species, *Leptophryne borbonica* usually inhabits a stream in the lower elevation of mountain forest that did not provide a high level of moisture (Inger & Stuebing 1997; Iskandar 1998; Malkmus 2002).

The population of *Leptophryne cruentata* was greater in Cibodas compared to any other sites, however, the frogs in Cibodas scattered in three sub-sites. In Selabintana, we did not find the frog in other sub-sites other than Cibereum. A similar pattern was also documented in Goalpara. We could not confirm the absence of this frog in other sites other than Rasta Waterfall since we did not survey any other potential sites in this area due to several constraints that limit our sampling efforts. Overall, the number of *Leptophryne cruentata* estimated in this study was relatively lower compared to previous studies (Liem 1971; Kusrini et al. 2007), indicating the population of this frog is decreasing. Despite the widespread distribution of *Leptophryne cruentata* at various sites in GPNP, their overall number is still distressing.

These findings can be used as baseline information for conservation authorities to widen their area of concerns other than Cibodas as potential habitats for *Leptophryne cruentata*. Decreasing population and

**Table 2.** Summary of median values and upper and lower 95% confidence intervals (in parentheses, derived from 10,000 bootstrap samples) for four parameters recorded at four locations.

Species	Location	Background Noise	Annual Temperature	Annual Precipitation	Elevation
<i>Leptophryne borbonica</i> (N = 8)	Bodogol	63.05(53.3 - 69.7)	23.23485(0)	297(297 - 325)	821.5(738 - 896)
<i>Leptophryne cruentata</i> (N = 23)	Cibodas	68.2(64.8 - 81.3)	18.91216(0)	373(0)	1661(1632 - 1703)
<i>Leptophryne cruentata</i> (N = 9)	Goalpara	73.2(66.8 - 73.2)	17.24538(0)	338(0)	1384(1381 - 1389)
<i>Leptophryne cruentata</i> (N = 11)	Selabintana	75.8(73.2 - 83s.5)	17.24538(0)	343(0)	1501(1488 - 1526)

distribution sites of its sister species, *Leptophryne borbonica*, are an important issue that needs to be addressed in order to prevent the local extinction of this species in the future.

### AUTHOR CONTRIBUTION

M.I.N. designed the study and supervised all the processes. M.I.N. also conducted the analysis and wrote the paper with assistance from all authors. R.T.I., P.Y.G., and A.D.L. assisted in conducting field observation and providing the data. B.D. helped in providing information about locations potentially selected for study and conducted literature reviews.

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### CONFLICT OF INTEREST

We declared that this research has no conflict of interest.

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