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Short Communication: A rapid survey of herpetofauna diversity in Bama coastal forest at Baluran National Park, Indonesia

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Abstract. *Siddiq AM, Wimbaningrum R, Sulistiyowati H, Setiawan R, Setiawan A, Wahono ND. 2024. Short Communication: A rapid survey of herpetofauna diversity in Bama coastal forest at Baluran National Park, Indonesia. Biodiversitas 25: 2323-2329.* Scientific reports on herpetofauna in Baluran National Park (BNP) are still limited. Meanwhile, several geographical areas, such as the Bama Baluran National Park coastal forest, have potential herpetofauna diversity within this conservation area yet to be reported. Therefore, this study aimed to determine the diversity of herpetofauna species in BNP's Bama coastal forest (BCF). The method was conducted using the Visual Encounter Survey (VES) in three tracks, conducted by combining Time Restricted Search (TRS) or using observation time for five hours during the mid-afternoon (06.00 AM-11.00 AM) and four hours at night (07.00 PM-11.00 PM) on each track. This study recorded 17 herpetofauna species, comprising 6 amphibian and 11 reptile species, in the BCF of Baluran National Park. The diversity index of herpetofauna species in this area was moderate category (H'=2.25). Species *Fejervarya limnocharis* Gravenhorst 1829 (38 individuals) has the highest abundance in the BCF and was found in track 1 (swamp area). Meanwhile, three species have the lowest abundance, such as *Kaloula baleata* Müller 1836, *Microhyla palmipes* Boulenger 1897, and *Cryptoblepharus balinensis* Barbour 1911, with 1 individual in each species.

Keywords: Bama coastal forest, Baluran National Park, diversity, herpetofauna

INTRODUCTION

Baluran National Park (BNP) is a conservation area on the eastern tip of Java Island. It is an essential habitat for several wild animal groups, including mammals (Pudyatmoko et al. 2018) and avifauna (Siddiq et al. 2024); however, scientific reports about herpetofauna in BNP are still limited. Based on citizen science records (iNaturalist 2023), 17 species of herpetofauna are reported in BNP, consisting of 8 amphibians and 9 reptiles. Moreover, conservation areas should ideally have a high species richness of herpetofauna, likely in Alas Purwo National Park (APNP), with 63 species, consisting of 15 amphibian species and 48 reptile species (Yanuarefa et al. 2012). Therefore, more research is crucial to exploring the existence and diversity of herpetofauna species in BNP. For example, several areas in BNP, particularly the Bama coastal forest, could potentially be habitats for herpetofauna species.

Bama coastal forest (BCF) is a coastal ecosystem area characterized by lowland tropical forest and mangrove vegetation, with species composition including *Rhizophora mucronate* Lam., *Rhizophora apiculata* Blume, *Rhizophora stylosa* Griffith, *Ceriops tagal* (Perr.) C.B.Rob., *Bruguiera gymnorrhiza* (L.) Lam., *Aegiceras corniculatum* (L.) Blanco, *Avicennia marina* (Forssk.) Vierh., *Sonneratia alba* Sm., *Lumnitzera racemose* Willd., and *Nypa fruticans* Wurmb (Hariyanto et al. 2019; Asadi and Pambudi 2020; Sasea et al. 2022). However, scientific information on this coastal forest vegetation is still limited. Istomo and Hartato (2019) reported that six tree species dominate in the Bama coastal forest such as *Grewia eriocarpa* Juss., *Corypha utan* Lam., *Bombax valetonii* Hochr, *Terminalia catappa* L., *Schleichera oleosa* (Lour.) Oken, and *Syzigium polyanthum* (Wight) Walp.. Furthermore, this coastal forest also has areas with mud, loam, and slightly rocky substrate types (Hariyanto et al. 2019). This condition is considered one of the habitat characteristics for herpetofauna, which prefers vegetated areas and is close to water. The BCF is suspected to be a suitable habitat for herpetofauna in the BNP. However, it has never been scientifically reported regarding the diversity of herpetofauna species in this coastal forest.

Herpetofauna diversity is an important indicator of ecosystem equilibrium (Aguillón-Gutiérrez 2019; Silva et al. 2020). Most herpetofauna species are carnivores and key food web species (de Miranda 2017). Herpetofauna species can control the prey population rate at a lower trophic level; therefore, these species contribute to maintaining the energy flow balance in an ecosystem. Furthermore, the information on the herpetofauna's existence must be reported scientifically. Previously, the species composition of herpetofauna in Java and Bali was reported by Kusrini et al. (2021), with a total of 238

species, including 43 amphibian species and 195 reptile species. Meanwhile, exploration of herpetofauna species in several natural forest areas in East Java has also been reported by Yanuarefa et al. (2012) in the Alas Purwo National Park; Kurniawan et al. (2018) in the Sukamade Resort at Meru Betiri National Park; Rohman et al. (2022) in the Brantas River and Baihaqi et al. (2022) in the Ledok Ombo Natural Tourism Area at Malang, with various species richness in each area.

Revealing more herpetofauna species diversity in East Java, especially in conservation areas such as Baluran National Park, is essential for complementing and updating the data on herpetofauna diversity on Java Island. Therefore, this study aims to determine the composition and diversity of herpetofauna species in the Bama coastal forest of BNP. This study is expected to provide complementary data on the existence of herpetofauna species in BNP. Furthermore, it can also be used to determine wildlife conservation policies, especially those related to herpetofauna species in Baluran National Park.

MATERIALS AND METHODS

Study area

The study was conducted in the Bama coastal forest of BNP (Figure 1) on three days survey from 5 to 7 May 2023. According to Nuzula et al. (2017), Baluran National Park has a dry climate F type with an average air humidity of 77% and air temperatures around 27.2°C to 30.9°C. Herpetofauna observation was carried out in three transect tracks with different area characteristics, i.e., Track 1: swamp and coastal forest vegetation (7°50'45"S, 114°27'33"E-7°50'36" S, 114°27'38E), Track 2: coastal dry forest areas (7°50'40"S, 114°27'34"E-7°50'49"S, 114°27'27"E), and Track 3: mangrove edge areas (7°50'51" S, 114°27'27"E-7°50'46"S, 114°27'10"E). Bama coastal forest (BCF) has two vegetation types, such as lowland tropical vegetation (dominated by *G. eriocarpa*, *C. utan*, *Bombax valetonii* Hochr, and *T. catappa*, respectively) and mangrove vegetation (dominated by *R. mucronata*, *R. apiculata*, *R. stylosa*, *C. tagal*, and *B. gymnorrhiza*, respectively) (Hariyanto et al. 2019; Istomo and Hartato 2019; Asadi and Pambudi 2020; Sasea et al. 2022).

Data collection

This research was conducted using the Visual Encounter Survey (VES) (Boullhesen et al. 2021) in three tracks at BCF. The track used has a length of 400 meters, totaling 1,200 meters. Each track also has a five-meter width from the right to the left side for herpetofauna observation. Therefore, the total area of the study is 1.2 hectares. Ecological data collected included herpetofauna species, their abundance, and habitat types. The VES method is carried out by combining Time Restricted Search (TRS) or using observation time for five hours during the forenoon (06.00 AM-11.00 AM) and four hours at night (07.00 PM-11.00 PM) on the path observed; these are the peak times for herpetofauna ecological activities (Erawan et al. 2021). Three observers conducted data collection, and each species found was documented using a Canon EOS 60D DSLR, a Kit Lens Canon 18-55mm, and a Telephoto Lens Thamron 75-300mm. Herpetofauna species identification was identified using the identification guidebook (Horner 2007; Yanuarefa et al. 2012; Das 2015).

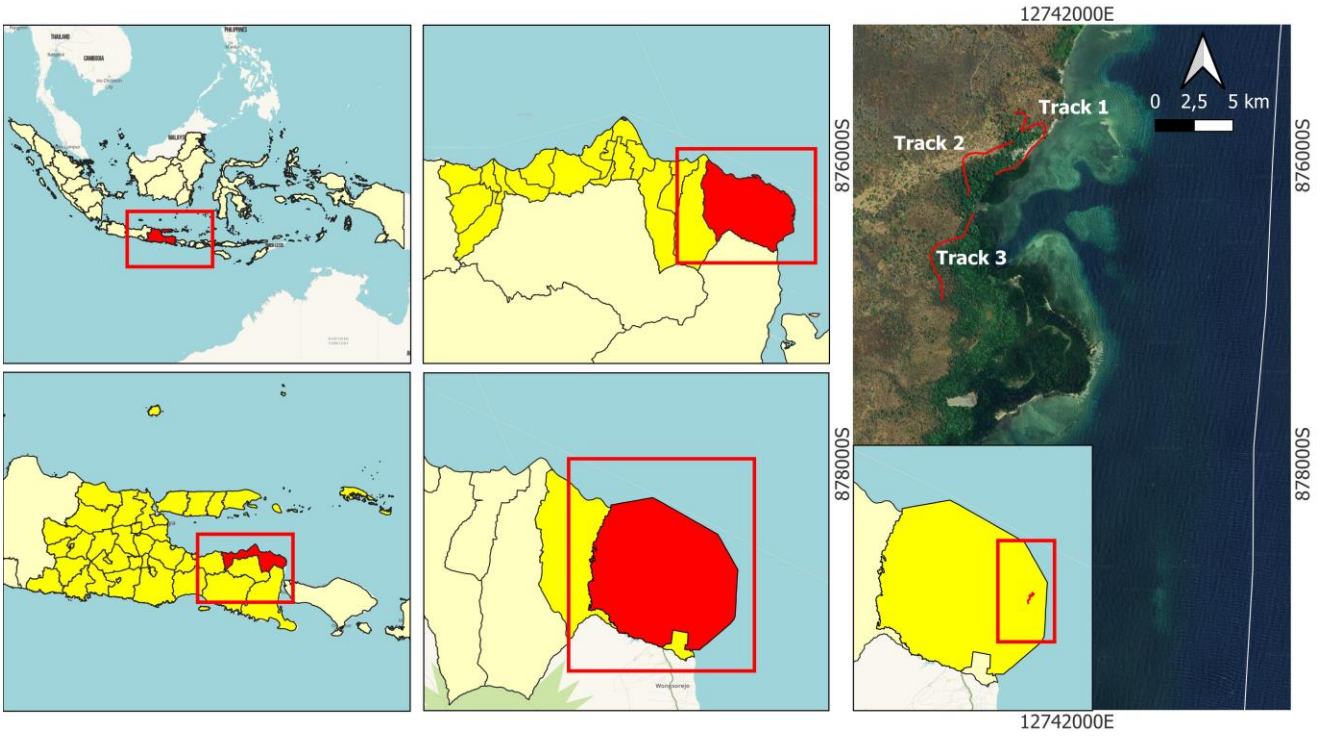

Figure 1. Study sites for herpetofauna survey at Bama Coastal Area, Baluran National Park, Banyuputih, Situbondo, East Java, Indonesia

Data analysis

The herpetofauna species composition is determined by taxonomy information, including class, family, and species. Furthermore, additional information is also provided with the three conservation statuses, such as The International Union for Conservation of Nature (IUCN) Red List (https://www.iucnredlist.org/), Convention of International Trade in Endangered Species (CITES) (https://cites.org/eng), and Minister of Environment and Forestry Regulation of Indonesia No.P.106/MENLHK/SETJEN/KUM.1/12/2018 concerning protected plant and animal species. Finally, the diversity index was calculated by the Shannon-Weaver index (H') and run by the Rstudio program using a vegan package (R Core Team 2021), with the formula (Oksanen 2016):

$$H = -\sum_{i=1}^{S} p_i \log_b p_i$$

Where :

H' : Shannon-Weaver Index
Pi : the proportion of species i
S : the number of species
b : the base of the logarithm

RESULTS AND DISCUSSION

This study recorded 17 herpetofauna species, comprising 6 amphibian and 11 reptile species, in the BCF of Baluran National Park (Table 1). According to these results, there are 13 species previously reported by citizen scientists from Inaturalist (2023) during 2014-2023 in BNP, i.e., *Ingerophrynus biporcatus* Gravenhorst 1829, *Fejervarya limnocharis* Gravenhorst 1829, *Kaloula baleata* Müller, 1836, *Microhyla achatina* Tschudi 1838, *Microhyla palmipes* Boulenger 1897, *Draco Volans* Linnaeus 1758, *Cyrtodactylus marmoratus* Gray 1831, *Gekko gecko* Linnaeus, 1758, *Hemidactylus frenatus* Duméril and Bibron 1836, *Hemidactylus platyurus* Schneider 1797, *Varanus salvator* Laurenti 1768, *Dendrelaphis pictus* Gmelin 1789, and *Trimeresurus insularis* Kramer 1977. Furthermore, 4 species were not reported by citizen science data collection (iNaturalist 2023) in BNP, i.e., *Ingerophrynus parvus* Boulenger 1887, *Eutropis multifasciata* Kuhl 1820, *Cryptoblepharus balinensis* Barbour 1911, and *Indotyphlops braminus* Daudin 1803. Additionally, *I. parvus* was found on Track 2 and Track 3, whilst *E. multifasciata* was only found on Track 2., coastal forest floor areas rarely passed by tourists or the general public; these species were discovered on the forest floor, leaf litter, and weathered trees. This follows the statement of Yanuarefa et al. (2012), which revealed that *I. parvus* and *E. multifasciata* in Alas Purwo National Park were distributed in terrestrial habitats, particularly in the forest floors and unpolluted environments.

The species *In. braminus* was found on Track 2 under a weathered tree (Figure 2). This species is a fossorial snake that inhabits underground and under-weathered trees. This snake is native to tropical Asia and probably native to Sri Lanka or southern India (Wallach 2009). Currently, this species has accidentally been introduced to many regions worldwide, such as Africa, Australia, America regions (North, Central, and South parts), and Asia (including Indonesia) (Shea et al. 2021). In the East Java region, *I. braminus* was also reported in Alas Purwo National Park (Yanuarefa et al. 2012) and Meru Betiri National Park (Kurniawan et al. 2018). Furthermore, *C. balinensis* was only found in Track Line 2, precisely on tree trunks and between the bark at a height of approximately 2 meters (Figure 2). This lizard chooses arboreal habitats with large and woody tree forests for its ecological activities. The species *C. balinensis* is endemic to the islands of Java and Bali, as well as smaller islands such as Madura, Karimun, and Kangean Islands (Horner 2007).

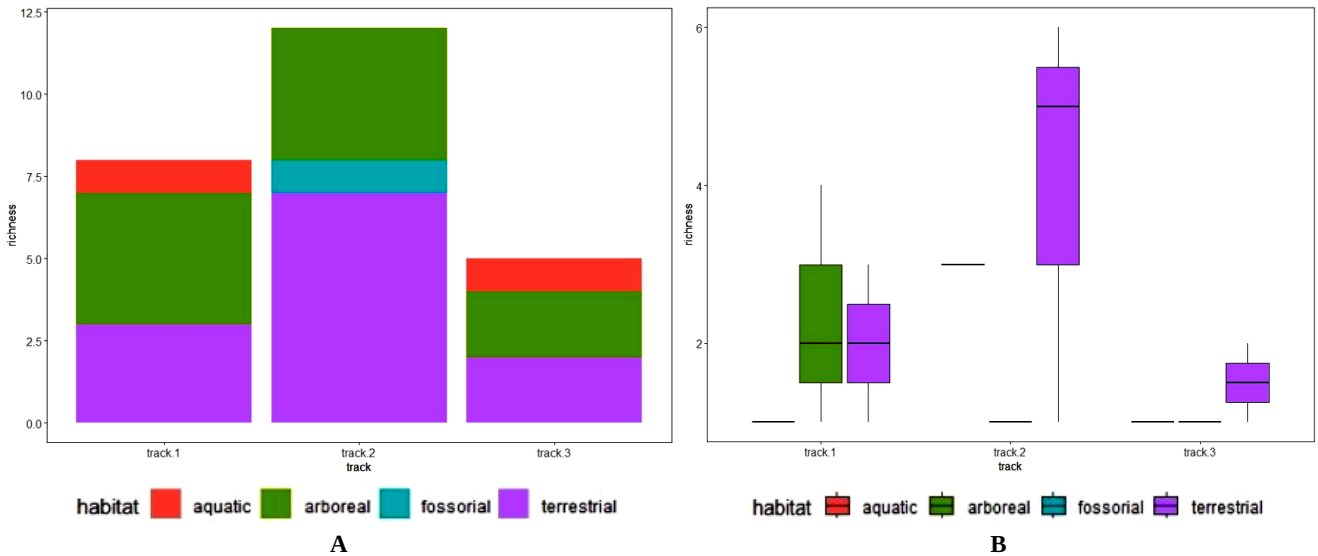

Figure 2. The richness of herpetofauna species in each track at BCF, Baluran National Park: A. Total; B. Per habitat types

Table 1. Species composition of herpetofauna in BCF, Baluran National Park, East Java, Indonesia

Class: Family Species	English name	Conservation atatuses			Average of abundance			Habitat types
		IUCN	CITES	IR	T1	T2	T3	
Amphibi: Bufonidae								
*Ingerophrynus biporcatus**	Indonesian Toad	LC	NA	NP	0	5	0	Terrestrial
Ingerophrynus parvus	Lesser Malacca Toad	LC	NA	NP	0	10	3	Terrestrial
Amphibi: Dicroglossidae								
Fejervarya limnocharis	Boie's Wart Frog	LC	NA	NP	38	0	0	Terrestrial; aquatic
Amphibi: Microhylidae								
Kaloula baleata	Muller's Narrowmouth Toad	LC	NA	NP	0	1	0	Terrestrial
*Microhyla achatina**	Javan Chorus Frog	LC	NA	NP	2	0	0	Terrestrial
*Microhyla palmipes**	Pengalengan Rice Frog	LC	NA	NP	1	0	0	Terrestrial
Reptile: Agamidae								
*Draco volans***	Common Flying Dragon	LC	NA	NP	0	3	1	Arboreal
Reptile: Gekkonidae								
*Cyrtodactylus marmoratus***	Marbled Bow-fingered Gecko	LC	NA	NP	4	0	0	Arboreal
Gekko gecko	Tokay Gecko	LC	NA	NP	5	0	0	Arboreal
Hemidactylus frenatus	Common House Gecko	LC	NA	NP	9	0	0	Arboreal
Hemidactylus platyurus	Asian flat-tailed house gecko	LC	NA	NP	4	0	0	Arboreal
Reptile: Scincidae								
Eutropis multifasciata	Common Mabuya	LC	NA	NP	0	6	0	Terrestrial
*Cryptoblepharus balinensis***	Snake-eyed Skinks	LC	NA	NP	0	1	0	Arboreal
Reptile: Varanidae								
Varanus salvator	Common Water Monitor	LC	NA	NP	0	2	1	Terrestrial, aquatic
Reptile: Colubridae								
Dendrelaphis pictus	Common Bronzeback	LC	NA	NP	0	2	0	Terrestrial, arboreal
Reptile: Viperidae								
*Trimeresurus insularis**	White-lipped Island Pitviper	LC	NA	NP	0	2	2	Terrestrial, arboreal
Reptile: Thyplopidae								
Indotyphlops braminus	Brahminy Blind Snake	LC	NA	NP	0	2	0	Fossorial

Notes: *endemic to Jawa; **endemic to Jawa-Bali. Abbreviation as follows: International Union for Conservation of Nature (IUCN), Least Concern (LC), Not Appendix (NA), Indonesia Regulation (IR), Not Protected (NP), Track 1 (T1), Track 2 (T2), Track 3 (T3)

There are four habitat types of herpetofauna in BCF that were occupied by 17 herpetofauna species, including terrestrial, arboreal, aquatic, and fossorial (Table 1). This is also similar to the herpetofauna in Alas Purwo National Park, which consists of four habitat types (Yanuarefa et al. 2012). Furthermore, based on track, the highest richness of herpetofauna species was found in Track 2 (10 species), followed by Track 1 (7 species) and Track 3 (4 species), respectively. However, there are differences in species richness for each track; Track 1 and Track 3 observed herpetofauna species with terrestrial, aquatic, and arboreal habitat types, while Track 2 observed herpetofauna species with terrestrial, arboreal, and fossorial types (Figure 2).

According to the IUCN Red List, all herpetofauna species found have the Least Concern (LC) category. This category describes that the species has a low-risk extinction category; hence, it still has an abundant population in the wild (IUCN 2024). However, based on population trends in the IUCN Red List, two species have indications of declining populations, i.e., *I. parvus* and *M. palmipes*. According to the IUCN SSC Amphibian Specialist Group (2021), *I. parvus* has a declining population trend due to land clearing for urban areas, logging, and massive utilization of non-timber crops. Furthermore, *M. palmipes* also has a declining population trend due to land clearing for urban areas, agriculture, aquaculture, mining, animal hunting, and water-land pollution (IUCN SSC Amphibian Specialist Group 2018). These factors can lead to natural habitat loss for both species, specifically risk to *M. palmipes*, an endemic Indonesian frog species. However, information on these two species' presence in the BNP's Bama coastal forest shows that this conservation area is their maintained natural habitat that supports their natural necessities.

Furthermore, referring to CITES shows that all herpetofauna species found have a not appendix (NA) category, which indicates that all species found are not regulated in international trade. Furthermore, based on the Minister of Environment and Forestry Regulation of Indonesia (2018), all the herpetofauna species found in the BCF of Baluran National Park are not included in the protected species; this is because the species found generally have populations that tend to be maintained in Indonesia. Although not protected, these conservation efforts must continue to be carried out both within conservation areas, such as BNP, or outside conservation areas. This conservation is crucial because herpetofauna has an important role in the ecosystem's food web and is an environmental bioindicator (Openg 2022). It was reported that nine herpetofauna species in the oil palm

agroecosystem of Sumatra have potential roles as predators, parasitoids, or pathogens.

In the BCF of Baluran National Park, two reptile species are predators, i.e., *V. salvator* and *T. insularis* (Figure 3). The *V. salvator* is a common predator and scavenger species that hunt prey in terrestrial, arboreal, and aquatic areas (Briggs-Gonzalez et al. 2022). In Thailand, this lizard species catches fish prey such as *Oreochromis aureus* Steindachner 1864, *Clarias gariepinus* Burchell 1822, and *Monopterus albus* Zuiew 1793 (Cota and Sommerlad 2013). This species also has behavior that minimizes socializing with other lizards, and social activities of this species only occur during the mating process, food struggles, and conflicts over their territory (Bennet 1998). Meanwhile, *T. insularis* is a crepuscular and nocturnal snake found in BCF, forest floor, and herbaceous vegetation; this snake hunter species feeds on frogs, lizards, small birds, and mammals (Lang 2011).

Figure 2. Several herpetofauna species in BCF, Baluran National Park: A. *Trimeresurus insularis*; B. *Indotyphlops braminus*; C. *Varanus salvator*; D. *Eutropis multifasciata*; E. *Hemidactylus frenatus*; F. *Gekko gecko*; G. *Cryptoblepharus balinensis*; H. *Fejervarya limnocharis* ; I. *Ingerophrynus parvus*

Herpetofauna species' diversity index (H') in the BCF of Baluran National Park is 2.25, or moderate category; the richness and evenness of the herpetofauna species found influence it. The species richness is moderate category, with a total of 17 species. A previous herpetofauna study in Java revealed that 35 species were found in Mount Galunggung West Java (Riyanto et al. 2019), 32 species were found in the Sukamade Resort at Meru Betiri National Park East Java (Kurniawan et al. 2018), and 18 species in the Sumberawan Area, Malang District, East Java (Baihaqi et al. 2022). Furthermore, the abundance of each herpetofauna species in BCF of Baluran National Park tends to be even because the range is 1-13 individuals per species; it can also be stated that no species dominates in this area. Therefore, based on both species richness and average abundance of each species, the diversity of herpetofauna species in the BCF of Baluran National Park is included in the medium category and is also considered an important part of ecosystem stability.

Species *F. limnocharis* (38 individuals) has the highest abundance in the BCF of Baluran National Park (Figure 3). This species was only found in Track 1, the terrestrial and aquatic (swamp area), suspected to be suitable for *F. limnocharis.* This follows Kusrini et al. (2021), who state that this species can be found in semi-aquatic to aquatic areas such as rice fields, rivers, and around watersheds with a maximum altitude of 700 masl. In addition, it is suspected that the swamps in the Bama coastal forest are used as breeding or spawning grounds by *F. limnocharis*, which is also evidenced by the discovery of many tadpoles on the edge of the swamps.

Three species with the lowest abundance are *K. baleata*, *M. palmipes,* and *C. balinensis*, with one individual in each species due to ecological factors, including solitary behavior, reproductive ability, and habitat preference. *K. baleata* habitat preferences are secondary forests, primary forests, and former logging areas (IUCN SSC Amphibian Specialist Group 2022). On the other hand, *K. baleata* can also be found in settlements such as plantations, flower pots, and holes in trees (Kusrini et al. 2021). Therefore, this species tends to be more commonly found in areas near settlements, while in the Bama coastal forest, only 1 individual was found in Track Line 2 on the forest floor with an area of leaf litter.

The study revealed that the diversity of herpetofauna species in BNP's Bama coastal forest is important information for managers and staff. Indirectly, this study also provides essential information about the energy flow system in this area. These species are primary and secondary predatory, and most are tertiary consumers (predators), meaning they control the prey species' population rate at the trophic level below. Thus, the existence of these herpetofauna species in this area is very important. Furthermore, another exploration and periodic monitoring of herpetofauna species should be carried out in other geographical areas of BNP, either by researchers or BNP staff, to reveal the whole diversity of herpetofauna in this conservation area.

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