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The Current Report of Herpetofauna in Enggano Island, Bengkulu, Indonesia, with Two New Record of Amphibian Species

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Abstract

Enggano Island has a unique and interesting endemic species to study. Data collection on the Enggano's herpetofauna was last carried out in 2015, and there was a data gap for six years. Therefore, it is necessary to research herpetofauna diversity on the island. The study used Visual Encountered Survei (VES) combined with patch and time search sampling at diurnal and nocturnal active times. We also compiled the data on herpetofauna species in books, journal publications, database specimens from museums worldwide, and recorded observations of individual species. We surveyed four research sites on Enggano Island (Kaana, Malakoni-Apoho, Meok, and Banjarsari). We preserved some specimens for each unprotected species in ethanol 70% and identified with Sumatran herpetofauna field guide. From the research, we concluded that there are 15 species of herpetofauna found in this study (4 species of amphibians and 11 species of reptiles). We found 2 endemic species of the island (Draco modiglianii and Cnemaspis modiglianii). Previous research has not reported two new record species of amphibians i.e., Fejervarya limnocharis and Duttaphrynus melanostictus. This research has not yet represented herpetofauna's true diversity on Enggano Island. The number of these species can still increase along with expanding the research study area, especially in conservation areas managed by Directorate General of Forestry for the protection and preservation of nature (BKSDA). Continuous exploration and monitoring need to be carried out to ensure future conservation management

Keywords: *Biodiversity; Enggano; Herpetofauna; New record*

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INTRODUCTION

Enggano is an island located in southwestern Sumatra Mainland (in the Indian Ocean) and about 170 km from Bengkulu Province (S: 53° 8' and E: 102° 25') (Bakar, 2009). The island has unique biodiversity due to its geological history, which has never been merged with Sumatra mainland (aka. Oceanic Island) and as part of the Mentawai Fault (Maryanto et al., 2017). Biodiversity on oceanic islands can be both especial and vulnerable due to their isolation, distinct habitats, and evolutionary processes (Sadler, 1999). Understanding and conserving biodiversity on oceanic islands is crucial for preserving unique and endemic species, maintaining ecosystem functions, and promoting sustainable development in these ecologically sensitive environments (Ceríaco et al., 2022; Gillespie, 2001).

Amphibians and reptiles (herpetofauna) are essential ecosystem components often used as environmental damage indicators. Human activities such as forest encroachment for agriculture and illegal logging can decrease species richness and abundance of amphibians and reptiles (Aguilar et al., 2013; Webb et al., 2012). Data collection on the Enggano herpetofauna was carried out in 2015 by the Enggano Island expedition team, Indonesian Institute of Sciences (LIPI). The expedition recorded two species of amphibians and 20 species of reptiles. Among them, there are four species of reptile's endemic to the island of Enggano: *Cnemaspis modiglianii* (Modigliani Rock Lizard), *Draco modiglianii* (Modigliani Flying Lizard), *Hemiphyllodactylus engganoensis* (Enggano Slender Lizard), and *Coelognathus engganensis* (Enggano Rat Snake) (Vinciguerra, 1892; Das, 2005; Grismer et al., 2014; Maryanto et al., 2017).

Six years since the expedition, no study of amphibians and reptiles has been recorded on Enggano island. The gap years regarding the biodiversity reports in an area may have an impact, such as loss of information to understand the local ecosystem and the populations of species present, undetected potential environmental damage or decline due to habitat changes, and difficulty making sustainable decision in conservation and environmental management (Carpio et al., 2014; Takacs & O'Brien, 2023). Therefore, knowing the current condition of herpetofauna species on Enggano Island is necessary.

METHOD

Research Site

This research was carried out on 3–17 September 2021 in 5 villages (Kaana, Malakoni, Apoho, Meok and Banjarsari), Enggano Island, Enggano District, North Bengkulu Regency, Bengkulu Province (Figure 1). Here is the description of the four-site observation at each village,

a. Kaana Site: Kaana village is ± 10,5 km from the basecamp in Malakoni Village (45 minutes by car). In Kaana, we surveyed the secondary forest near the coast, creek, rice field, and some areas of smallholder plantation.
b. Malakoni-Apoho Site: Malakoni and Apoho Village become one site of the area survey because Apoho has a small area and is located side by side with Malakoni Village. Malakoni-Apoho survey site consists of a swamp near the Malakoni harbor, secondary

forest near the coast, riparian, rice field, smallholder plantation, and human settlement.

c. Meok Site: The village is about 7 km from the base camp (30 minutes by car). The survey site consists of a ricefield, smallholder plantation, creek, and secondary forest near the coast.
d. Banjarsari Site: The village is about 15 km from the base camp (1 hour and 30 minutes by car). The survey site consists of a secondary forest near the coast, mangrove area, and smallholder plantation.

Further, identification and morphometry will be carried out at the Zoology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, University of Bengkulu.materials and how a complete description of the material is obtained. General tools and materials do not need to be written down.

Data Collection

Sampling was conducted in 5 villages (4 sites) that could be reached by roadway transportation on Enggano Island. Each location was explored for two days. We used the direct encounter method (Visual Encounter Survey; VES) combined with patch and time search sampling. The VES method is suitable for obtaining species list data and the relative abundance of species (Kusrini, 2019). The sampling is carried out at the active time of herpetofauna, diurnal (08.00–11.00 am), and nocturnal (07.00–10.00 pm). The data taken during sampling are coordinates of the specimen found using a GPS receiver, description of the location (vegetation, substrate, weather, and animal activity), and the time the specimen was found. The specimens obtained were identified using various Sumatran herpetofauna references (Das, 2010; Mistar et al. 2017; Kaprawi et al., 2020; Kusrini, 2020). We preserved some specimens for each unprotected species. We euthanized the specimens using benzocaine through injection then fixed it using formalin 4%. Later, we preserved the specimens in ethanol 70%. We also compile the data of herpetofauna species that available or have been published before (book, journal publication, database specimens of museum in the world (retrieve from GBIF.org (2024)), and recorded observations of individual species in iNaturalist website. We use this data to compare with our survey results.

RESULTS AND DISCUSSION

The available data in the literature, museum catalogue (GBIF.org, 2024), and recorded observation (iNaturalist, 2024), listed 30 species found in Enggano Island. During the survey, we encountered 15 species (4 amphibians and 11 reptiles), 50% of the total listed species in Enggano Island (Table 1). The severe weather (rainy and intense wind) and potholes in remote areas caused the nonoptimal observation results. The five sampling sites are villages on the island's northeast coast that can be reached by roadway. Unfortunately, reaching the southwest coast of Enggano Island is difficult e.g. narrow rivers can only be reached by boat for a few kilometres.

Figure 1. Enggano Island map and four site of this survey (yellow pin): 1. Kaana Site; 2. Apoho-Malakoni Site; 3. Meok Site; and 4. Banjarsari Site. The map owned by BKSDA Bengkulu.

Interestingly, we recorded two new species of amphibia that have yet to be reported in any literature and database (i.e., *Duttaphrynus melanostictus* and *Fejervarya limnocharis*). We also found 2 of 4 endemic species of Enggano, i.e *Draco modiglianii* and *Cnemaspis modiglianii*. There is a species listed as Endangered under the IUCN red list (*Cuora amboinensis*) and Appendix I by CITES (Cota et al., 2020; Shelley & Metz, 2023). A region with protected and endemic species requires long-term conservation management. Adopting sustainable management techniques guarantees that endemic species and their habitats are not harmed by human activity in the region (Dudley, 2008). The activities could involve managing tourism responsibly, preserving and repairing natural habitats, managing invasive species, and reducing habitat loss brought on by human activities like urbanization, agriculture, and logging. By considering these crucial factors as well as the presence of endemic and/or protective species, we can successfully safeguard regions, aiding in the preservation of biodiversity and preserving ecosystem health.

During the observation, we encountered 188 individuals of 15 species, i.e., Bufonidae (one species), Dicroglossidae (two species), Ranidae (one species), Agamidae (one species), Scincidae (one species), Gekkonidae (three species), Varanidae (one species), Homalopsidae (one species), Elapidae (one species), Pythonidae (one species), Geoemydidae (one species), Crocodilydae (one species) (Table 2). Species observed on each site were: nine species in Kaana, 14 species in Malakoni-Apoho, eight species in Meok, and ten species at Banjarsari. The highest number of individuals found in Malakoni-Apoho site (74 individuals; 14 species), followed by Kaana (44 individuals; 9 species), Meok (40 individuals; 8 species), and Banjarsari (34 individuals; 10 species). Malakoni-Apoho have several types of habitats that suitable for herpetofauna to live, i.e. Kuala Besar River (*Crocodylus porosus* and *Cuora amboinensis*), docks (*Laticauda colubrina*), coastal, swamps, human settlement, rice field, and plantation. Meanwhile in Meok, we are sampling at rice field, smallholder plantation, creek, and secondary forest near the coast where these areas are not the habitat of some species such as *Crocodylus porosus* and *Laticauda colubrina.* The number of species and individuals found during a survey can be influenced by various factors. In this survey we used only one method (VES method). The thoroughness and methodology of the survey can significantly impact the number of species detected. Zwerts et al., (2021) state that Factors such as survey duration, sampling intensity, sampling techniques (e.g., trapping, visual surveys, acoustic monitoring), and expertise of surveyors can influence species detection rates.

Table 1. Species list of herpetofauna from the survey and references. Abbreviation: MVZ: Museum of Vertebrate Zoology, University of California; USNM: Smithsonian National Museum of Natural History

No	Species	Family	This Study	Literature		GBIF Museum Data (2023)		iNaturalist observation data (2023)
				Vinciguerra, 1892	Maryanto et al., 2017	MVZ	USNM	
				Amphibia				
1	*Duttaphrynus melanostictus*	Bufonidae	v	-	-	-	-	-
2	*Fejervarya limnocharis*	Dicroglossidae	v	-	-	-	-	-
3	*Limnonectes shompenorum*	Dicroglossidae	v	v	v	v	-	v
4	*Hylarana nicobariensis*	Ranidae	v	v	v	v	-	v
				Reptile				
5	*Draco modiglianii*	Agamidae	v	v	v	v	v	v
6	*Draco sumatranus*	Agamidae	-	-	-	-	-	v
7	*Lipinia relicta*	Scincidae	-	v	v	-	-	-
8	*Eutropis multifasciata*	Scincidae	v	v	v	v	v	v
9	*Eutropis rudis*	Scincidae	-	-	-	-	v	-
10	*Cnemaspis modiglianii*	Gekkonidae	v	v	v	v	-	-
11	*Hemidactylus frenatus*	Gekkonidae	v	-	v	v	-	v
12	*Gehyra mutilata*	Gekkonidae	-	v	-	-	-	v
13	*Lepidodactylus lugrubis*	Gekkonidae	-	v	v	v	-	-
14	*Hemiphyllodactylus engganoensis*	Gekkonidae	-	-	v	-	-	-
15	*Cyrtodactylus marmoratus*	Gekkonidae	-	v	-	-	-	-
16	*Gekko kuhlii*	Gekkonidae	v	v	v	v	v	-
17	*Gekko monarchus*	Gekkonidae	-	-	-	-	-	v
18	*Varanus salvator*	Varanidae	v	v	v	-	v	-
19	*Cerberus schneiderii*	Homalopsidae	v	v	v	v	v	v
20	*Laticauda colubrina*	Elapidae	v	v	v	-	v	v
21	*Malayophyton reticulatus*	Pythonidae	v	-	v	-	-	-
22	*Coelognathus enganensis*	Colubridae	-	v	v	-	-	-
23	*Psammodynastes pulverulentus*	Psammodynastidae	-	v	v	v	v	v
24	*Rhamphotyhlops lineatus*	Typhlopiidae	-	-	v	v	-	-
25	*Indotyphlops braminus*	Typhlopiidae	-	-	-	-	-	v
26	*Cuora amboinensis*	Geoemydidae	v	v	v	v	v	v
27	*Notochelys platynota*	Geoemydidae	-	-	-	-	-	v
28	*Eretmochelys imbricata*	Cheloniidae	-	-	-	-	-	v
29	*Chelonia mydas*	Cheloniidae	-	-	v	-	-	-
30	*Crocodylus porosus*	Crocodilydae	v	-	v	-	-	-
	Total species		**15**	**16**	**20**	**12**	**9**	**15**

Table 2. Species list of herpetofauna and number of individuals at each village during the survei: Site 1 Kaana, Site 2 Malakoni-Apoho, Site 3 Meok, and Site 4 Banjarsari

No.	Species	Family	Indonesian Name	Number of Individuals			
				Site 1	Site 2	Site 3	Site 4
			Amphibia				
1	*Duttaphrynus melanostictus*	Bufonidae	Kodok-buduk asia	15	13	8	6
2	*Fejervarya limnocharis*	Dicroglossidae	Katak tegalan	0	1	0	0
3	*Limnonectes shompenorum*	Dicroglossidae	Bangkong shompen	3	7	3	2
4	*Hylarana nicobariensis*	Ranidae	Kongkang nicobar	12	18	14	10
			Reptilia				
5	*Draco modiglianii*	Agamidae	Cicak terbang modigliani	0	4	2	1
6	*Eutropis multifasciata*	Scincidae	Kadal tanah bergaris	3	4	4	3
7	*Cnemaspis modiglianii*	Gekkonidae	Cicak batu modigliani	0	0	0	1
8	*Hemidactylus frenatus*	Gekkonidae	Cicak rumah	5	7	4	3
9	*Gekko kuhlii*	Gekkonidae	Cicak terbang kuhl	2	2	1	1
10	*Varanus salvator*	Varanidae	Biawak air	3	2	3	4
11	*Cerberus schneiderii*	Homalopsidae	Ular bakau schneider	3	4	0	2
12	*Laticauda colubrina*	Elapidae	Ular laut belang	0	7	0	0
13	*Malayophyton reticulatus*	Pythonidae	Ular sanca batik	1	1	0	0
14	*Cuora amboinensis*	Geoemydidae	Kura-kura batok	0	1	0	0
15	*Crocodylus porosus*	Crocodilydae	Buaya muara	0	3	0	0
			Total (Individual)	**44**	**74**	**40**	**34**

Information of the Species Found from the Survey: Class Amphibia

In this study, *Duttaphrynus melanostictus* and *Fejervarya limnocharis* were reported as new records compared to the latest exploration by LIPI (now BRIN) in 2017 and updated iNaturalist observation database. The specimen can be identified as *D. melanostictus* (Figure 2b) by the characters: the parotoid gland is elliptical; supraorbital groove is continuous with the groove supratympanic and no parietal groove; scattered black bumps on the upper part of the body with a pointed snout; fingers and toes tips black and rounded; two tubercles on the palm; toes half webbed with black rounded tips; two metatarsal tubercles of equal sizes are flat (Iskandar, 1998; Kusrini, 2013). There is no significant variation in morphology compared to the reference. *D. melanostictus* is well known as a cosmopolitan species and can be found in almost all habitats on Enggano Island (e.g., agricultural land, urban areas, near the swamp, and secondary forest). However, we can't conclude the Enggano Island population's species origin and introduction process. It needs further analysis based on population genetics, such as Eprilurahman et al., (2021), that appraised the origin of Sulawesi and Timor's population of *Microhyla orientalis*.

While for *F. limnocharis* (Figure 2c), we found only one individual that snares in the old-unused well at diurnal sampling. The well is located near a small river and agricultural land. Once we surveyed the river and agricultural area, we only found *Hylarana nicobariensis* and *D. melanostictus*. The specimen can be identified as *F. limnocharis* by the characters: small to medium (SVL ♂ 30–40 mm); wrinkled skin texture with elongated warts parallel to the body axis; fingertips are blunt and not broad; pointed toes with non-flared ends; on the skin, there are lumps on the top, often the lumps are irregular in shape; web formula I 1–2 II 1–2 III 1–22/3 IV 2–11/2 V (Kusrini, 2013;

Yodthong et al., 2019). There is no significant variation in morphology compared to the reference.

Hylarana nicobariensis (Figure 2a) and *Limnonectes shompenorum* (Figure 2d) have been listed since the first exploration by Vinciguerra (1892) to the latest exploration by LIPI in Maryanto et al., (2017). The two species are also distributed on the Sumatra mainland. *H. nicobariensis* is the most abundant and common in Enggano Island. Alongside *D. melanostictus*, it can be found in almost all habitats on this island. *H. nicobariensis* is the only species of the genus distributed in Indonesia, while others dispersed to India (incl. Nicobar, Andaman Island) and Sri Lanka (Frost, 2023). We found *L. shompenorum* mainly after rain during nocturnal sampling. It can be found in the swamp, paddy fields, and puddles formed from vehicle tracks. The study of *L. shompenorum* from the Enggano Island population has been studied by (Gonggoli et al., 2023). This study revealed the large genetic distance within the *L. shompenorum* populations and found distinctive morphology characters between the Enggano Island population and its type locality (Nicobar Island). The biodiversity of Enggano Island is fascinating to study because of the island's geological history. Being isolated from other populations for a long time urges the genetic population study.

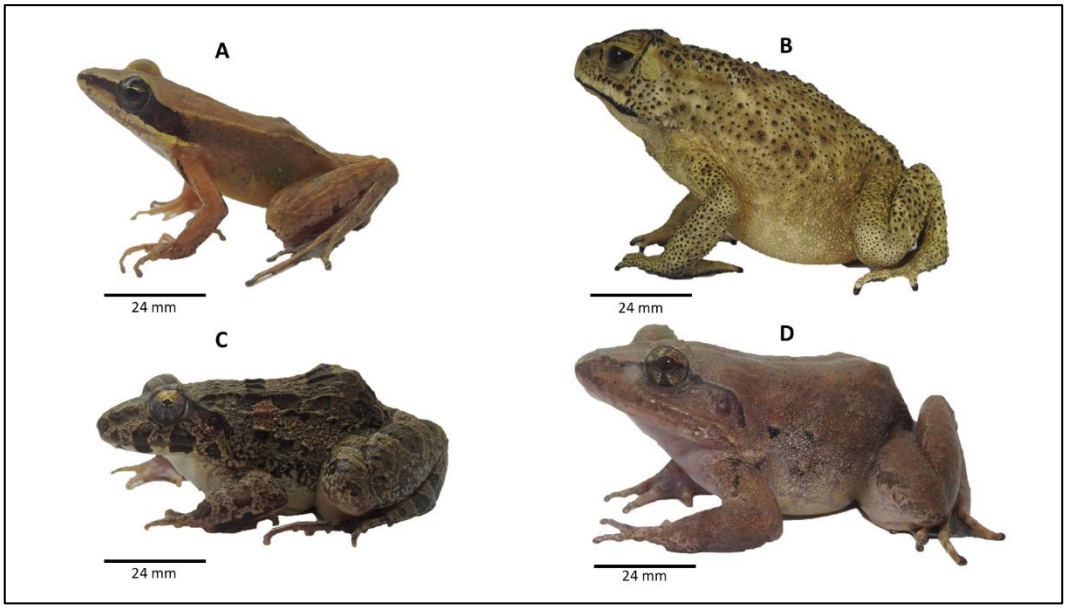

Figure 2. The amphibian's species found from the survey: **(a)** *Hylarana nicobariensis* **(b)** *Duttaphrynus melanostictus* **(c)** *Fejervarya limnocharis* **(d)** *Limnonectes shompenorum*. Scale bar = 24 mm. Photographed by VYA.

Information of the Species Found from the Survey: Class Reptilia

We found 11 species from 9 families (Agamidae, Scincidae, Gekkonidae, Varanidae, Homalopsidae, Elapidae, Pythonidae, Geoemydidae, and Crocodylidae). *Draco modiglianii* and *Cnemaspis modiglianii* are the endemic species of the island. *D. modiglianii* was found in the coastal and urban areas while basking in the tree (e.g., palm (*Elaeis guineensis*), mango (*Mangifera indica*, and melinjo (*Gnetum gnemon*))

(Figure 4e). While for *C. modiglianii (Figure 3b),* we encountered only one individual during diurnal sampling at a banner root tree (*Xylocarpus granatum*) near the mangrove area in the Banjarsari site. The small size and cryptic color (light to dark brown) make it difficult to spot the species.

Eutropis multifasciata and *Varanus salvator* are the common species we observe during diurnal sampling. *E. multifasciata* is mainly found in urban and plantation areas while basking. However, we also encountered *E. multifasciata* eating tourist leftover food (e.g., rice and biscuit) at Bak Blau Lagoon, Meok Village (Figure 4d). *Varanus salvator* is spotted during the daytime while crossing the road from one habitat to another near the riverbanks. While fishing on riverbanks and swamps, the local people usually encountered the lizard. *V. salvator* is semi-aquatic and has a variety of habitats (swamp, river, and canals) (Das, 2010). There are nine (small and large) rivers on Enggano Island (Regen, 2011), which explains that the water monitor is frequently found on this island.

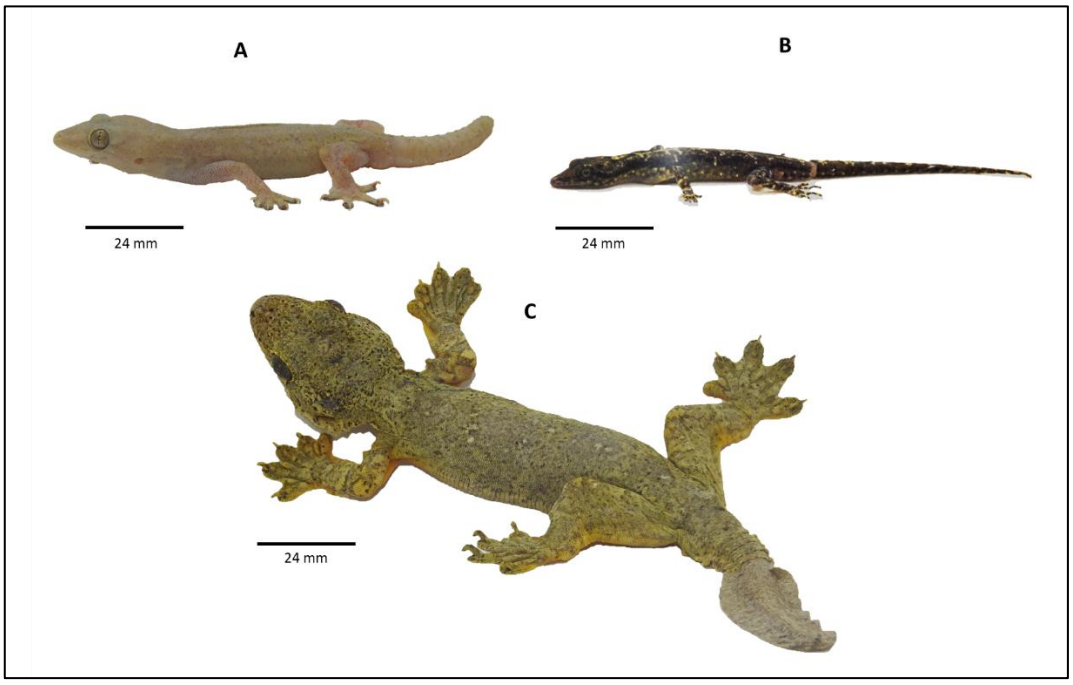

Figure 3. Gekkonids found from the survey: **(a)** *Hemidactylus frenatus,* **(b)** *Cnemaspis modigliani,* and **(c)** *Gekko kuhlii*. Scale bar = 24 mm. Photographed by VYA

During nocturnal sampling, we spotted two species of Gekkonidae (*Gekko kuhlii* and *Hemidactylus frenatus*) and two species of snake (*Cerberus schneiderii* and *Laticauda colubrina*). *G. kuhlii* was found by the team while camouflaging on the bark of *Terminalia cattapa* tree in the coastal area (Figure 3c). This species is a widespread gliding gecko occurring in lowland primary and secondary forests up to 800 a.s.l. (Das, 2010). Grismer (2011) also reported the presence of this species in coastal habitats on small islands in Peninsular Malaysia. The species can also be found on the wooden buildings adjacent to suitable habitats. Meanwhile, the house gecko, *H. frenatus* is abundance in human settlement (Figure 3a). We can find them near the lamp in the house while hunting their food such as flying termites.

Cerberus schneiderii and *Laticauda colubrina* are the common snake species on the island. *C. schneiderii* is a semi-aquatic species found in several habitats such as swamps, mangroves, estuaries, and coastal areas when the low tide of seawater (Figure 4a). *L. colubrina* is a highly venomous (neurotoxin) sea snake (Das, 2010). It is spotted near the dock (Figure 4b). During the daytime, they hide on piles of rocks, while at night, some individuals are spotted climbing up to the dock area in Malakoni site.

Outside the survey time, we spotted *Crocodylus porosus* basking on the side of the Kuala Besar River (Figure 4f). It was recorded on video while the survey team followed *PDAM* (Indonesian Regional Water Utility Company) officer to check on the water pipe. When we arrived upstream of the river, there was a cave, and the survey team spotted *Malayophyton reticulatus (Figure 4c)*. We took the python to the base camp for documentation then released it to its original habitat. Once, a local people reported to the survey team that they found *Cuora amboinensis* in the daytime while fishing at Kuala Besar river.

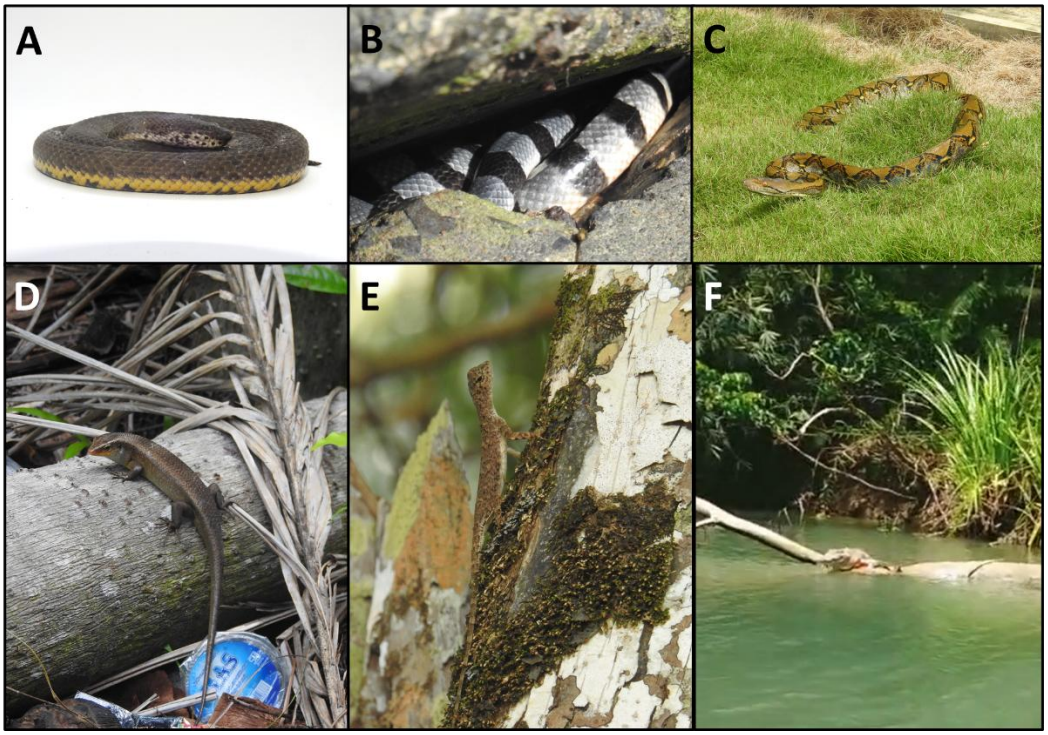

Figure 4. Other reptile species spotted during the survey: **(a)** specimen of *Cerberus schneiderii*; **(b)** *Laticauda colubrina* hiding on pile of rocks at Malakoni Dock; **(c)** *Malayophyton reticulatus* taken to basecamp from a cave at upstream of Kuala Besar River; **(d)** *Eutropis multifasciata* looking for food on pile of trash at Bakblau Lagoon; **(e)** *Draco modigliani* basking in the palm tree; and **(f)** *Crocodylus porosus* basking on a bark at Kuala Besar riverside. **A-E** photographed by VYA; **F.** video captured by Syam.

Preservation and conservation effort by the local people

In the last ten years, the biodiversity of Enggano Island has undergone various threats, such as forest fire, illegal logging (e.g., Merbau tree), mangrove deforestation, and illegal sand mining (Maryanto et al., 2017). In 2017, the indigenous community of Enggano Island declared a joint commitment to saving and preserving the Enggano Island ecosystem. The Head of the BKSDA Bengkulu and the local government witnessed the declaration. There are five statements declared by Pa'buki (the head of the indigenous community of Enggano Island). The declaration has the essence that all communities that live on the island are committed to saving the natural resources and ecosystem under the applicable laws and regulations, prioritizing the principle of sustainability and refusing to plant oil palm, and preserving the native flora and fauna species of the island from illegal hunting and trafficking (Bakar, 2009). The diversity of herpetofauna of Enggano Island is still a lot that has not been explored. Two new records and four endemic species are potential diversity that needs to be preserved. Further surveys need to be conducted by increasing the sampling area to the island's southwest coast to reveal its diversity. The species population of the island is also an interesting study because of the island's geological history as an oceanic island that has never been merged with the Sumatra mainland.

CONCLUSION

This research is not yet represent the true diversity of herpetofauna on Enggano Island. There are still many areas of this island that still need to be explored. The number of these species can still increase along with the expanding the research study area, especially in conservation areas managed by BKSDA. Efforts by the government and local communities to protect the island's habitat are essential to maintain species' survival, especially endemic species. Continuous exploration and monitoring need to be carried out to ensure future conservation management.

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author contributions

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