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On some additions to the amphibians of Gunung Inas Forest Reserve, Kedah, Peninsular Malaysia

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Abstract: A survey on amphibian fauna was conducted in compartments 15, 16, and 17 of Gunung Inas Forest Reserve (GIFR), Kedah, Peninsular Malaysia for a period of two-and-a-half years, starting from January 2016 to May 2018, with a total of 20 visits. Observations and collections of amphibian species were carried out in and along the rivers, forest streams, forest pools, rock pools, cascade areas, waterfalls, ditches, temporary pools, forest floors, and forest trails. In total, 41 species of amphibians, belonging to 25 genera, and seven families were collected over the survey period. Of these, 11 species were ranids, followed by 10 dicroglossids, seven rhacophorids, six microhylids, four bufonids, two megophryids, and a single ichthyophiids (Ichthyophis sp.). From these observations, it is being pointed out that 15 species of amphibians represent new records for GIFR, while two species were not detected. This increases the known amphibian diversity of Gunung Inas Forest Reserve from 28 to 41 species.

Keywords: Anura, checklist, diversity, mountain, rainforest, river.

Bahasa Malaysia: Tinjauan ke atas fauna amfibia telah dijalankan di kompartmen 15, 16 dan 17 Hutan Simpan Gunung Inas (GIFR), Kedah, Semenanjung Malaysia, selama dua tahun setengah, bermula pada Januari 2016 sehingga Mei 2018, sebanyak 20 kali lawatan. Pemerhatian dan pengumpulan spesies amfibia telah dijalankan di dalam dan di sepanjang sungai, alur sungai hutan, lopak air hutan, lopak batu, kawasan jeram, air terjun, parit, lopak air sementara, lantai hutan dan trek hutan. Keseluruhannya, 41 spesies amfibia, daripada 25 genera dan tujuh keluarga telah dikumpul sepanjang tempoh tinjauan. Daripada jumlah ini, 11 spesies adalah ranid, diikuti 10 dicroglossid, tujuh rhacophorid, enam microhylid, empat bufonid, dua megophryid, dan satu ichthyophiids (Ichthyophis sp.). Daripada pemerhatian ini, telah dikenalpasti 15 spesies amfibia merupakan rekod baru bagi GIFR, sementara dua spesies tidak dapat dikesan. Ini telah meningkatkan diversiti amfibia yang diketahui di Hutan Simpan Gunung Inas daripada 28 ke 41 spesies.

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INTRODUCTION

Banjaran Bintang Hijau is the third largest mountain range in Peninsular Malaysia, and located on the west coast. Its structure, which include hills, slopes, peaks, plateaus, streams, and rivers influences the landscape of northern Peninsular Malaysia. This important mountain range extends approximately 140 km from Bukit Besar, Thailand to the central Malaysian state of Perak. The highest peak in this mountain range is Gunung Bintang (1,862 m), followed by Gunung Bintang Utara (1,835 m) and Gunung Inas (1,801 m), which is within the state of Kedah. The Gunung Inas Forest Reserve (GIFR) is part of Banjaran Bintang Hijau, and placed in the district of Baling, Kedah. This forest reserve is managed by the South Kedah Forest Department. This forest reserve covers 37,346 ha of lowland dipterocarp, hill dipterocarp, lower montane and upper montane forests (Kiew 1998; Manokaran 1998). Tree species, such as Shorea curtisii (Meranti Seraya), Shorea leprosula (Meranti Tembaga), Shorea macroptera (Meranti Melantai), Scorodocarpus borneensis (Kulim), Artocarpus elasticus (Terap Nasi), Ficus conglomerata (Ara), Artocarpus lanceifolius (Keledang), Callophyllumm sp. (Bintangor), Koompassia excelsa (Tualang), Alstonia angustiloba (Pulai), Macaranga sp. (Mahang), and Dipterocarpus sp. (Keruing) can be found here. The understorey of the forest is dominated by bushes, ferns, herbs, palms, bamboos, climbers, fungi, and epiphytes. The forest floor receives little light and is covered by leaf litter, twigs, tree branches, and logs. Several important rivers, including the Sungai Sedim, Sungai Reyau, Sungai Teruna, Sungai Badang, and Sungai Tawar drain through this forest reserve. These rivers flow to Sungai Muda which empties into the Straits of Malacca.

Research on the amphibian fauna has been undertaken at various locations in Kedah. These include a study in Ulu Muda Forest Reserve (UMFR), which recorded 56 species of frogs (Norhayati et al. 2005); Gunung Jerai where 14 species were recorded (Ibrahim et al. 2006a); Langkawi Island where 16 and 24 species were recorded respectively (Grismer et al. 2006; Ibrahim et al. 2006b); Beris Valley where 14 species were recorded (Shahriza et al. 2011a); Lata Bukit Hijau where 18 species were recorded (Shahriza et al. 2011b); Gunung Inas Forest Reserve (GIFR) where 28 species were recorded (Ibrahim et al. 2012a); Bukit Perangin Forest Reserve (BPFR) where 15 species were documented (Ibrahim 2012b); Tupah Recreational Forest (TRF) where 13 species were documented (Shahriza et al. 2013a); and Ulu Paip Recreational Forest (UPRF) where 20 species were documented (Shahriza & Ibrahim 2014).

Previous studies on the amphibian diversity (Ibrahim et al. 2012a) and reptile diversity (Shahriza et al. 2013b) have been conducted in GIFR. Ibrahim et al. (2012a) reported 28 species of amphibians, belonging to 21 genera and six families. This included 10 species of ranids, eight dicroglossids, four bufonids, three rhacophorids, two megophryids, and one microhylid (Ibrahim et al. 2012a). This study was undertaken over a period of six months. In this study, we surveyed a larger area including compartments 15, 16, and 17 of GIFR and for a longer duration of 30 months, in the hope that additional amphibian species would be recorded with greater survey effort.

MATERIALS AND METHODS

We observed and collected amphibians in compartments 15, 16, and 17 of GIFR (5.416N, 100.782E; elevation <300m) (Figure 1), between January 2016 and May 2018, with a total of 20 visits. Surveys were carried out along the Gunung Bintang Trail (Trail 1), Sungai Reyau Trail (Trail 2), Sungai Sedim Trail (Trail 3), Sungai Teruna Trail (Trail 4), and around Sungai Sedim Recreational Forest. Amphibians were observed and inspected in and along the rivers, forest streams, ditches, swampy areas, forest pools, rock pools, animal wallows, waterfalls, cascade areas, forest floors, among leaf litter, and under logs or buttress.

Specimens were collected at night, between 2000 and 2400 h, via active sampling or opportunistic encounters, by teams of three to five people. The amphibians were captured by hand or sweep nets. The specimens were kept in moist plastic bags and brought back to the laboratory for measurements and further inspections. In the laboratory, the snout-vent length (SVL) and head width (HW) of the captured specimens were measured using a digital calliper (LC= 0.1 mm). Voucher specimens were prepared by euthanizing the specimens with tricane. Specimens were fixed with 10% formalin, stored in 70% ethanol and deposited at the School of Pharmaceutical Sciences, Universiti Sains Malaysia (USM) for reference. Tissue samples (thigh muscles) of some selected species were collected, stored in 95% ethanol and deposited at the same location for further analysis. The specimens were photographed in situ or in the laboratory, using an Olympus digital camera, model SP800. Species identification was based on morphological characteristics, such as body shape, colour, pattern, webbing, fingers and toes following



Figure 1. Map of Peninsular Malaysia, showing Gunung Inas Forest Reserve (GIFR) in Kedah

Berry (1975), Ibrahim et al. (2008), and Grismer (2011), while taxonomic nomenclature followed Frost (2021). Identification of *Rentapia flavomaculata* followed Chan et al. (2020a), *Limnonectes deinodon* followed Dehling (2014), *Microhyla mukhlesuri* followed Hasan et al. (2014), and *Pulchrana sundabarat* followed Chan et al. (2020b).

RESULTS

Forty-one amphibian species, belonging to 25 genera and seven families were recorded from compartments 15, 16, and 17 GIFR. These included 11 ranids, 10 dicroglossids, seven rhacophorids, six microhylids, four bufonids, two megophryids, and a single ichthyophiid (Table 1). Comparison of amphibian species recorded by Ibrahim et al. (2012a) and this study is presented in Table 2.

Species accounts

Family Bufonidae

Duttaphrynus melanostictus (Schneider, 1799)

16USM-GIFR-DM01

Adult male, SVL= 58 mm, HW= 27 mm

An adult male was captured beside the road, along the way to Sungai Sedim Recreational Forest, in January 2016. The choruses of this species were recorded in November 2016 and October 2017, along the roadside ditches.

Ingerophrynus parvus (Boulenger, 1887) (Image 1) 16USM-GIFR-IP01

Adult male, SVL= 47 mm, HW= 21 mm

The specimen was collected in November 2016, hiding among leaf litter on the forest floor, along Sungai Reyau trail.

Rentapia flavomaculata Chan, Abraham & Badli-Sham, 2020

This tree toad was observed in September 2016 and October 2017, perched on the branches of a tree situated adjacent to the river (4–6 m above ground). In October 2017, seven adult males were detected, while actively calling from tree branches along the banks of Sungai Sedim.

Phrynoidis asper (Gravenhorst, 1829) (Image 2)

This river toad and its chorus were observed in every visit to GIFR. The toad was very common and often sighted perched on the wet granite rocks or bounders, hiding under big rocks or resting on the ground along the banks of Sungai Sedim, Sungai Reyau, and Sungai Teruna. Additionally, the toads were also encountered living along the small forest streams, forest floors, ditches, near the base camp and in the toilets. Sometimes they can be found resting on tree branches, 2–3 m above the ground.

Family Dicroglossidae

Fejervarya cancrivora (Gravenhorst, 1829)

An adult was sighted in June 2016 and October 2017. When first observed, it was found on the ground, at the edge of a temporary ditch, along the way to Sungai Sedim Recreational Forest.

Fejervarya limnocharis (Gravenhorst, 1829)

16USM-GIFR-FL01,02

Adult male, SVL= 44, 49 mm, HW= 19, 21 mm This medium-sized dicroglossid and its choruses were recorded in every visit to GIFR. It was very common and



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Table 1. Amphibian checklist of Gunung Inas Forest Reserve, Kedah, Peninsular Malaysia

	2016		2017				2018			
Таха	Jan.	Jun.	Sep.	Nov.	Mar.	Jul.	Oct.	Dec.	Feb.	May.
Bufonidae (4 species)										
Duttaphrynus melanostictus	x	-	-	X,V	-	-	X,V	-	-	-
Ingerophrynus parvus	-	-	-	х	-	-	-	х	-	х
Rentapia flavomaculata	-	-	X,V	-	-	-	X,V	-	-	-
Phrynoidis asper	X,V									
Dicroglossidae (10 species)										
Fejervarya cancrivora	-	х	-	-	-	-	х	-	-	-
Fejervarya limnocharis	X,V									
Limnonectes blythii	х	-	х	-	-	-	х	х	-	х
Limnonectes utara*	-	-	-	-	-	-	х	-	-	-
Limnonectes deinodon	-	-	-	-	х	х	-	-	-	-
Limnonectes malesianus	-	-	-	х	-	-	-	x	-	-
Limnonectes plicatellus	-	-	-	-	х	-	-	x	-	-
Occidozyga sumatrana	-	х	х	х	-	-	-	-	х	-
Occidozyga lima	х	-	-	-	-	-	х	-	-	-
Occidozyga martensii*	-	-	Х	-	-	Х	-	-	-	-
Megophryidae (2 species)										
Leptobrachium hendricksoni	-	х	-	-	-	-	-	Х	-	х
Pelobatrachus nasutus	-	-	-	V	-	-	х	v	-	V
Microhylidae (6 species)										
Kaloula pulchra*	-	-	-	х	-	х	-	-	-	-
Microhyla berdmorei*	-	-	X,V	X,V	-	-	-	-	-	-
Microhyla butleri*	-	х	-	-	-	Х	-	-	-	х
Microhyla mukhlesuri*	-	-	-	-	-	х	х	-	-	-
Microhyla heymonsi	X,V									
Phrynella pulchra*	-	-	-	-	-	-	-	x	-	-
Ranidae (11 species)										
Abavorana luctuosa	-	х	-	-	-	-	-	х	-	-
Hylarana nicobariensis	-	-	-	-	-	х	-	-	-	х
Amolops larutensis	X,V									
Chalcorana labialis	х	-	х	-	-	-	х	x	-	-
Humerana miopus	-	-	-	X,V	-	-	-	x	-	-
Hylarana erythraea	-	Х	Х	-	-	Х	-	-	Х	-
Odorrana hosii	X,V									
Odorrana monjerai	-	-	-	х	-	-	-	х	-	-
Pulchrana glandulosa*	-	-	-	V	V	X,V	V	-	-	V
Pulchrana laterimaculata*	-	-	-	-	-	X,V	-	-	-	-
Pulchrana sundabarat*	-	-	X,V	-	-	-	-	-	-	X,V
Rhacophoridae (7 species)										
Nyctixalus pictus	-	-	х	-	-	-	-	-	-	-
Polypedates discantus*	-	-	-	X,V	X,V	-	-	-	-	-
Polypedates leucomystax	-	X,V	-	-	X,V	-	X,V	X,V	-	-
Polypedates macrotis*	-	-	-	-	-	-	-	-	Х	-
Raorchestes parvulus*	-	-	Х	-	-	-	-	-	-	-
Rhacophorus nigropalmatus*	-	-	-	-	-	Х	Х	-	-	-
Zhangixalus prominanus	-	-	-	Х	-	-	Х	-	-	-
Ichthyophiidae (1 species)										
Ichthyophis sp.*	-	Х	-	-	-	-	-	-	-	-
Number of species (41 species)	9	13	15	17	10	15	18	17	8	13

X—Observed | ---Not observed | V—Vocalisations | *--New record.

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Table 2. Comparison of amphibian species in GIFR between past and present studies

Таха	Ibrahim et al. (2012a)	Present study (2018)	
Bufonidae (4 species)			
Duttaphrynus melanostictus	x	х	
Ingerophrynus parvus	х	Х	
Rentapia flavomaculata	x	Х	
Phrynoidis asper	х	Х	
Dicroglossidae (10 species)			
Fejervarya cancrivora	x	Х	
Fejervarya limnocharis	х	Х	
Limnonectes blythii	x	Х	
Limnonectes utara	-	Х	
Limnonectes deinodon	x	Х	
Limnonectes malesianus	x	Х	
Limnonectes plicatellus	х	х	
Occidozyga sumatrana	x	Х	
Occidozyga lima	х	Х	
Occidozyga martensii	-	Х	
Megophryidae (2 species)			
Leptobrachium hendricksoni	x	Х	
Pelobatrachus nasutus	x	х	
Microhylidae (6 species)			
Kaloula pulchra	-	Х	
Microhyla berdmorei	-	Х	
Microhyla butleri	-	Х	
Microhyla mukhlesuri	-	Х	
Microhyla heymonsi	x	Х	
Phrynella pulchra	-	Х	

Ranidae (13 species)		
Abavorana luctuosa	х	х
Hylarana nicobariensis	х	Х
Amolops larutensis	х	Х
Chalcorana labialis	х	Х
Hoplobatrachus rugulosus	х	-
Humerana miopus	х	Х
Hylarana doriae	х	-
Hylarana erythraea	х	Х
Odorrana hosii	х	х
Odorrana monjerai	х	х
Pulchrana glandulosa	-	х
Pulchrana laterimaculata	-	х
Pulchrana sundabarat	-	х
Rhacophoridae (7 species)		
Nyctixalus pictus	х	х
Polypedates discantus	-	Х
Polypedates leucomystax	х	х
Polypedates macrotis	-	х
Raorchestes parvulus	-	х
Rhacophorus nigropalmatus	-	х
Zhangixalus prominanus	х	Х
Ichthyophiidae (1 species)		
Ichthyophis sp.	-	Х
Number of species (43 species)	28 species	41 species

X—Observed | ---Not observed.

occupied various habitats, such as open areas, car parks, fields, bushes, under tall grasses, roadside ditches, cement ditches, and swamps. They breed in stagnant water bodies, including temporary puddles, rock pools, and isolated pools. The two voucher specimens were collected in open area, near a car park, after heavy rain in November 2016.

Limnonectes blythii (Boulenger, 1920) (Image 3)

16USM-GIFR-LB01

Adult, SVL= 127 mm, HW= 48 mm

This riparian species can be found along the banks of Sungai Sedim, Sungai Reyau and Sungai Teruna. It also can be encountered along the small forest streams, swampy areas and on the forest floors. In September 2016, an adult was captured, perched on tangled roots, on the banks of Sungai Teruna.

Limnonectes utara Matsui, Daicus & Norhayati, 2014 (Image 4)

17USM-GIFR-LU01

Adult, SVL= 68 mm, HW= 34 mm

An adult was collected perched on the wet mossy rock, in a small forest stream (1–2 m width), which flows to Sungai Sedim in October 2017. The area was shaded and surrounded by lowland dipterocarp forest. This species, earlier known by the name *L. kuhli*, represents a new record for GIFR.

Limnonectes deinodon Dehling, 2014

17USM-GIFR-LD01

Adult, SVL= 38 mm, HW= 20 mm

A single specimen was captured resting on a rotten log, on the banks of a small forest stream, along Sungai Reyau trail in July 2017.

Shahrudin



Image 1. Ingerophrynus parvus



Image 2. Phrynoidis asper



Image 3. Limnonectes blythii



Image 4. Limnonectes utara



Image 5. Limnonectes plicatellus



Image 6. Leptobrachium hendricksoni

Limnonectes malesianus (Kiew, 1984)

The frog was observed in November 2016 and December 2017. When first observed, it was found on the wet ground, near a temporary puddle, along Sungai Sedim trail after heavy rain.

Limnonectes plicatellus (Stoliczka, 1873) (Image 5)

17USM-GIFR-LP01

Adult, SVL= 45 mm, HW= 22 mm

The 'rhinoceros' frog was collected in March 2017, hiding among leaf litter, near a swampy area, along Sungai Sedim trail.

Occidozyga sumatrana (Peters, 1877)

16USM-GIFR-OS01,02

Adult, SVL= 37, 39 mm, HW= 15, 15 mm

In November 2016, two specimens were collected submerged in a temporary rain pool, along Sungai Reyau trail after heavy rain. Later three more individuals were also sighted in another rain pool along this trail.

Occidozyga lima (Gravenhorst, 1829)

16USM-GIFR-OL01

Adult, SVL= 39 mm, HW= 16 mm

An adult was captured hiding among leaf litter, near a rock pool, at the edge of Sungai Sedim in January 2016.

Occidozyga martensii (Peters, 1867)

16USM-GIFR-OM01

Adult, SVL= 35 mm, HW= 15 mm

A single specimen was captured in September 2016, hiding among the grasses, in a temporary rain pool, along Gunung Bintang trail. This is a new record for GIFR.

Family Megophryidae

Leptobrachium hendricksoni Taylor, 1962 (Image 6)

16USM-GIFR-LH01, 02

Adult, SVL= 53, 55 mm, HW= 32, 32 mm

Two specimens were caught, hiding under rotten log and dead leaves on the forest floor, along Sungai Reyau trail in June 2016. Tadpoles of this species were found inhabits in the rock pools and isolated pools along Sungai Sedim.

Pelobatrachus nasutus (Schlegel, 1858)

17USM-GIFR-PN01

Adult, SVL= 69 mm, HW= 37 mm

In October 2017, an adult male was captured hiding under a big rock, near a small forest stream, which flow to Sungai Sedim. The chorus ('*thak*') of this species were heard in November 2016, December 2017, and May 2018.

Microhylidae

Kaloula pulchra Gray, 1831

The frog was sighted in November 2016 and July 2017. On first observation, it was on the water surface, in a roadside ditch, along the way to Sungai Sedim Recreational Forest, after heavy rain. This is a new record for GIFR.

Microhyla berdmorei (Blyth, 1856) (Image 7)

16USM-GIFR-MB01

Adult, SVL= 42 mm, HW= 19 mm

A single specimen was captured concealed under dead leaves, near a rock pool, on the banks of Sungai Sedim in September 2016. The choruses of this species were heard in September and November 2016, along the banks of Sungai Sedim. This species represents a new record for GIFR.

Microhyla butleri Boulenger, 1900

This species was spotted in June 2016, July 2017, and May 2018, and often observed hiding under tall grasses, bushes, under dead leaves or under rotten log around Sungai Sedim Recreational Forest. They breed in stagnant water bodies, such as temporary puddles, rock pools and rain pools. This species represents a new record for GIFR.

Microhyla mukhlesuri Hasan, Islam, Kuramoto, Kurabayashi & Sumida, 2014

An adult was spotted in July and October 2017. When first observed, the frog was camouflaged among the grasses, in a temporary puddle, along Sungai Teruna trail. This species, previously known by the name *M. fissipes*, represents a new record for GIFR.

Microhyla heymonsi Vogt, 1911

16USM-GIFR-MH01, 02

Adult, SVL= 28, 30 mm, HW= 14, 14 mm

This microhylid and its chorus were observed and recorded in every visit to GIFR. They are ubiquitous and occupied various habitats, including disturbed and undisturbed areas. Two specimens were collected in November 2016, hiding under leaf litter and rocks, on the banks of Sungai Sedim.

Phrynella pulchra Boulenger, 1887 (Image 8)

A single specimen was observed perched on a twig, approximately 0.5 m above ground, along Gunung Bintang trail in December 2017. This is a new record for GIFR.

Shahrudin



Image 7. Microhyla berdmorei.

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Image 8. Phrynella pulchra



Image 9. Chalcorana labialis



Image 10. Humerana miopus



Image 11. Odorrana hosii



Image 12. Pulchrana sundabarat

Family Ranidae

Abavorana luctuosa (Peters, 1871)

An adult was detected in June 2016 and December 2017. On first observation, the frog was perched on a rotten tree buttress, near a puddle, along Sungai Reyau trail.

Hylarana nicobariensis (Stoliczka, 1870)

The frog was spotted in July 2017 and May 2018. On being first sighted, the specimen concealed itself among grasses, near a roadside ditch, along the way to Sungai Sedim Recreational Forest.

Amolops larutensis (Boulenger, 1899)

17USM-GIFR-AL01, 02

Adult, SVL= 46, 48 mm, HW= 25, 25 mm

This torrent frog and its chorus were observed in every visit to GIFR. They were very common and often perched on the wet mossy granite rocks or boulders, near waterfalls or cascades. When approached, the frogs jumped into the river or were seen hiding inside the rock crevices near the streams. In December 2017, two specimens were collected, perched on granite rocks, near cascade areas in Sungai Sedim.

Chalcorana labialis (Schlegel, 1837) (Image 9)

16USM-GIFR-CL01, 02

Adult, SVL= 47, 48 mm, HW= 22, 22 mm

Two adult males were collected in September 2016, perched on leaves of low vegetation, near swampy area, along Sungai Sedim trail. Other individuals were detected in January 2016, October 2017 and December 2017.

Humerana miopus (Boulenger, 1918) (Image 10)

17USM-GIFR-HM01

Adult, SVL= 85 mm, HW= 37 mm

In December 2017, a single specimen was captured at the edge of a forest pool, along Sungai Sedim trail. Two other individuals were also sighted in November 2016, at the same location, though they weren't collected.

Hylarana erythraea (Schlegel, 1837)

17USM-GIFR-HE01

Adult, SVL= 74 mm, HW= 33 mm

This human-commensal species was observed several times. In July 2017, an adult male was captured, hiding among tall grasses, near a roadside ditch, along the way to Sungai Sedim Recreational Forest.

Odorrana hosii (Boulenger, 1891) (Image 11)

17USM-GIFR-OH01, 02

Adult, SVL= 57, 59 mm, HW= 26, 26 mm

This poisonous rock frog is very common, and often found along the fast-flowing streams or cascade areas of the rivers. They were often perched on wet mossy rocks or boulders, rotten logs, creepers, small vegetation or tangle of roots, along the river banks. Sometimes, this species was sighted perched on tree branches or leaves, up to 2 m above the ground. Two adult males were captured in February 2018, perched on creeping plants (approximately 1.5 m above ground), on the banks of Sungai Sedim. This species and its call were detected in every visit to GIFR.

Odorrana monjerai (Matsui & Ibrahim, 2006)

An adult was sighted perched on rotten tree buttress, near a small forest stream, along Sungai Reyau trail in November 2016. Another specimen was observed in December 2017, along Gunung Bintang trail.

Pulchrana glandulosa (Boulenger, 1882)

The chorus of this species was recorded in November 2016, March 2017, July 2017, October 2017, and May 2018, along the banks of Sungai Teruna and roadside ditches. A single specimen was observed in July 2017, hiding among aquatic plants, in the roadside ditch, along the way to Sungai Sedim. This species denotes a new record for GIFR.

Pulchrana laterimaculata (Barbour & Noble, 1916)

In July 2017, an individual was observed, perched on a tree fern, at the swampy area, along Sungai Sedim trail. This species represents a new record for GIFR.

Pulchrana sundabarat Chan, Abraham, Grismer & Brown, 2020 (Image 12)

16USM-GIFR-PS01

Adult, SVL= 47 mm, HW= 21 mm

An adult male was collected in September 2016, while actively calling on a rotten log, along Gunung Bintang trail. Another specimen was observed in May 2018, and this species, previously by the name *P. picturata*, represents a new record for GIFR.

Rhacophoridae

Nyctixalus pictus (Peters, 1871)

An individual was observed resting on the leaves of small vegetation (approximately 0.5 m above ground), along Sungai Reyau trail in September 2016.

Shahrudin



Image 13. Polypedates discantus



Image 14. Rhacophorus nigropalmatus



Image 15. Zhangixalus prominanus

Polypedates discantus Rujirawan, Stuart & Aowphol, 2013 (Image 13)

17USM-GIFR-PD01

Adult, SVL= 53 mm, HW= 24 mm

In March 2017, an adult male was captured perched on the twig of a creeping plant (approximately 2 m above ground), at the edge of Sungai Sedim. Another individual was spotted in November 2016 along Gunung Bintang trail. This species, earlier known by the name *P. leucomystax*, denotes a new record for GIFR.

Polypedates leucomystax (Gravenhorst, 1829)

17USM-GIFR-PL01

Adults, SVL male= 48 mm, SVL female= 77 mm, HW male= 22 mm, HW female= 34 mm

An amplected pair was captured in December 2017, sitting on the ground, near an intermediate-sized rock pool, on the banks of Sungai Sedim. The choruses of this



Image 16. Ichthyophis sp.

species were also recorded in June 2016, March 2017, October 2017 and December 2017, along Sungai Sedim and roadside ditches.

Polypedates macrotis (Boulenger, 1891)

An adult was observed, resting on a tree branch (approximately 2 m above ground), near a temporary puddle, along Sungai Reyau trail in February 2018. This is a new record for GIFR.

Raorchestes parvulus (Boulenger, 1893)

An individual was sighted, perched on the leaves of a creeping plant (approximately 1.5 m above ground), along Gunung Bintang trail in September 2016. This represents a new record for GIFR.

Rhacophorus nigropalmatus Boulenger, 1895 (Image 14)

17USM-GIFR-RN01

Adult, SVL= 93 mm, HW= 41 mm

In October 2017, an adult was captured perched on leaves (approximately 2.5 m above ground), near an intermediate-sized forest pool, along Sungai Sedim trail after heavy rain. Another specimen was also observed in July 2017 at the same location, and this species denotes a new record for GIFR.

Zhangixalus prominanus (Smith, 1924) (Image 15)

16USM-GIFR-ZP01

Adult, SVL= 61 mm, HW= 27 mm

A single specimen was collected in November 2016, sitting on tree branch (approximately 1.5 m above ground), near a temporary rain puddle, along Gunung Bintang trail. Another individual was also sighted in October 2017 along Sungai Sedim trail.

Ichthyophiidae

Ichthyophis sp. (Image 16)

A juvenile, approximately 15 cm long, was sighted crawling on the mud, near a forest pool and later disappeared under leaf litter. It was encountered along Sungai Sedim trail in June 2016 and represents a new record of this caecilian genus for GIFR.

DISCUSSION

Fifteen species of amphibians, including *Limnonectes utara, Occidozyga martensii, Kaloula pulchra, Microhyla berdmorei, M. butleri, M. mukhlesuri, Phrynella pulchra, Pulchrana glandulosa, P. laterimaculata, P. sundabarat, Polypedates discantus, Raorchestes parvulus, Polypedates macrotis, R. nigropalmatus,* and *lchthyophis* sp. were incorporated to the list as new records for GIFR. Two species of frogs, *Hylarana doriae* and *Hoplobatrachus rugulosus,* which were detected in a previous study (Ibrahim et al. 2012a) were not detected during this survey. Thus, the diversity of amphibian in GIFR was increased from 28 to 41 species.

Limnonectes utara is a representative of Limnonectes kuhlii species complex, and was first described by Matsui et al. (2014) from Bukit Larut, Perak. The specimen from GIFR was congruent with that of *L. utara* in having dense warts on the tibia, full interdigital webbing between the toes and the first finger being slightly longer than the second (Matsui et al. 2014). This finding expands the northernmost distribution of *L. utara* by 110 km from

its type locality. *Polypedates discantus* is a member of *Polypedates leucomystax* species complex, and was described by Rujirawan et al. (2013) from Songkhla Province, southern Thailand. The morphology of the specimens found in GIFR were congruent with the description of *P. discantus* in having the following characters; the skin of the head does not co-ossify with the skull, and white dots on the thighs were absent (Rujirawan et al. 2013). Accordingly, the distribution of *P. discantus* was extended to 253 km south of its type locality. A single species of caecilian, *Ichthyophis* sp. was encountered. This juvenile caecilian had a yellow dorsolateral line on each side, and was not assigned to a species.

Rhacophorus nigropalmatus or Wallace's flying frog is probably not uncommon, but it is rarely encountered because of their arboreal behaviour. They only descend from the canopy during the breeding season (Dring 1979; Inger & Stuebing 1997) and prefer forest pools or animal wallows to breed (Inger & Stuebing 1997). In GIFR, R. nigropalmatus was found perched on tree branches or leaves, overhanging a stagnant water of forest pools. The intermediate-sized pool (approx. 4 m length x 2 m width) was shady and sheltered by lowland dipterocarp forest. Its water was turbid, had a muddy bed, and dead leaves and twigs accumulated at the bottom of the pool. Other frog species, such as P. leucomystax, L. blythii, and Humerana miopus were also sighted in the same pools. Tadpoles of two or three unknown frog species were also encountered in the pool. This might indicate the importance of forest pools as a breeding site for several frog species, including *R. nigropalmatus*. Two frog species, Hylarana doriae and Hoplobatrachus rugulosus recorded in GIFR by Ibrahim et al. (2012a) were not detected. We reviewed the material deposited by Ibrahim et al. (2012a), and we assigned the specimen they identified as H. doriae to L. blythii based on the morphological characters (large and stout body, broad head, obvious tympanum, supratympanic fold present, dark brown coloration on dorsal surface and dirty white on ventral surface). However, we could not confirmed the identity of the specimen Ibrahim et al. (2012a) assigned to H. rugulosus as the specimen was missing. To date, the only confirmed records of H. rugulosus in Malaysia are from disturbed areas in Sabah, where they are invasive (Inger & Stuebing 1989; Inger 2005).

Ibrahim et al. (2012a) referred to 11 frog species encountered in GIFR as rare (*P. nasutus, L. hendricksoni, D. melanostictus, L. malesianus, L. deinodon, L. plicatellus, H. erythraea, A. luctuosa, H. miopus, N. pictus,* and *Z. prominanus*). They are not rare species but (M)

are species with elusive and secretive behaviours that could otherwise be recorded with suitable /specialised sampling methods. For example, both *P. nasutus* and *L. hendricksoni* are typical forest frog species, which can be found on the forest floors of old secondary forests or primary rain forests. They are usually encountered hiding among leaf litter, under big rocks or under rotten logs (Berry 1975; Ibrahim et al. 2008; Grismer 2011). Additionally, its dorsal pattern and colouration are very similar to their surrounding environments (ground, leaf litter, and twigs), thus providing a perfect camouflage.

Duttaphrynus melanostictus and H. erythraea are frequently seen, human-commensal species living in disturbed environment where they breed in stagnant water bodies (Inger 2005; Grismer 2011). In our study, both of these species were more frequently observed around villages, chalets or toilets when compared to that within the forest reserve areas. They can also be encountered around the roadside ditches, especially after heavy downpour. Although not many individuals of Limnonectes deinodon were observed in GIFR, this species is not considered rare. They can be found if more effort and careful observation were made during sampling periods. Usually, these small dicroglossids are encountered perched on rocks or boulders, sitting on the ground or hiding under leaves along the rivulets. Humerana miopus also is not a rare species and is often found around swampy areas and forest pools in GIFR. This species is very sensitive to sound and can immediately disappear, making it very difficult to detect.

Some species of frogs were reported at nearby areas, but were not recorded in GIFR. They are *Limnonectes paramacrodon* which was encountered at Bukit Hijau, Tupah, and Ulu Paip, *Sylvirana malayana* at Bukit Perangin, *Rentapia flavomaculata* at Ulu Paip, and *lchthyophis nigroflavus* at Bukit Perangin. Ulu Paip, Bukit Hijau, Tupah, and Bukit Perangin are located 19, 24, 75, and 151 km from GIFR, respectively. According to Inger (2003), the presence of frog species in a particular area depends on various factors, including duration of sampling period, area of coverage, sampling technique, topography, weather, microhabitats, and activity pattern. Additionally, the physical characteristics of a stream also determine the presence and absence of frog species (Inger 1969).

From this research its shows that GIFR is very rich with amphibian species. Various type of habitats in GIFR contributed to higher richness of frog diversity. These included rivers, small forest streams, swamps, ditches, forest pools, rock pools, temporary pools, tree buttress pools and animal wallows, which provided suitable sites for amphibians to live and breed. Additionally, the presence of Banjaran Bintang Hijau with several prominent peaks such as Gunung Bintang and Gunung Inas influence the landscape of this area, which lead to the diverse amphibian species. Amphibians are essential to be conserved and protected as they play many important roles in the ecosystem. They are significant as a biological indicator, to control insects, as a prey for various types of predators and as medicinal species. Current research shows that amphibians skin secretions comprise various bioactive compounds including the antimicrobial peptides (AMPs), which is effective to various strains of bacteria (Conlon et al. 2008; Al-Ghaferi et al. 2010). These AMPs are able to use as a template, to develop and produce a new therapeutic agent (Conlon & Sonnevend 2011). Thus, amphibian species are required to be totally protected, so that the natural drugs resources, which have valuable potential are preserved forever. For a strategic conservation planning, their habitats and breeding sites must be defended and restricted from human disturbances. Deforestation and forest alteration for any purpose should be minimised or totally stopped in GIFR, so as to sustain and promote the amphibian richness and other biodiversity in general.

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