

A checklist of amphibians at Lubuk Semilang Recreational Park, Langkawi Island, Kedah, Peninsular Malaysia

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Abstract

A checklist of amphibians at Lubuk Semilang Recreational Park, Langkawi Island, Kedah, Peninsular Malaysia. A study on amphibian fauna at the lowland dipterocarp forest of Lubuk Semilang Recreational Park, Langkawi, Kedah, Peninsular Malaysia was conducted between December 2018 and June 2019. We recorded 18 species of amphibians from 14 genera and 6 families. These include seven new records for Lubuk Semilang, which are *Fejervarya limnocharis*, *Limnonectes hascheanus*, *Megophrys aceras*, *Kaloula pulchra*, *Microhyla butleri*, *Pulchrana laterimaculata*, and *Polypedates discantus*. We also recorded a new anuran record for Langkawi Archipelago, *Pulchrana laterimaculata*, and two endemic species of Malaysia, *Leptobrachium smithi* and *Limnonectes macrognathus*. Results from this survey indicate the amphibian species of the Langkawi Archipelago has increased from 28 to 29 species.

Data published through [GBIF](#) (Doi:[10.15470/f0diow](https://doi.org/10.15470/f0diow))

Key words: Lowland dipterocarp forest, Amphibian, Habitat, Diversity, Langkawi, Peninsular Malaysia

Resumen

Lista de control de anfibios del Parque Recreativo Lubuk Semilang, isla de Langkawi (Kedah), Malasia Peninsular. Entre diciembre de 2018 y junio de 2019 realizamos un estudio sobre la fauna anfibia del bosque dipterocarpo de tierra baja del Parque Recreativo Lubuk Semilang de Langkawi (Kedah), Malasia peninsular. Registramos 18 especies de anfibios pertenecientes a 14 géneros y 6 familias que incluyen siete nuevos registros en Lubuk Semilang: *Fejervarya limnocharis*, *Limnonectes hascheanus*, *Megophrys aceras*, *Kaloula pulchra*, *Microhyla butleri*, *Pulchrana laterimaculata* y *Polypedates discantus*. También registramos un nuevo anuro en el archipiélago de Langkawi, *Pulchrana laterimaculata*, y dos especies endémicas de Malasia, *Leptobrachium smithi* y *Limnonectes macrognathus*. Como resultado de este estudio, las especies de anfibios registradas en el archipiélago de Langkawi pasan de 28 a 29.

Datos publicados en [GBIF](#) (Doi:[10.15470/f0diow](https://doi.org/10.15470/f0diow))

Palabras clave: Bosque dipterocarpo de tierra baja, Anfibios, Hábitat, Diversidad, Langkawi, Malasia peninsular

Resum

Lista de control d'amfibis del Parc Recreatiu Lubuk Semilang, illa de Langkawi (Kedah), Malàisia Peninsular. Entre els mesos de desembre de 2018 i juny de 2019 vam portar a terme un estudi sobre la fauna amfíbia del bosc dipterocarp de terra baixa del Parc Recreatiu Lubuk Semilang de Langkawi (Kedah), Malàisia peninsular. Vam registrar 18 espècies d'amfibis pertanyents a 14 gèneres i 6 famílies que inclouen set nous registres a Lubuk Semilang: *Fejervarya limnocharis*, *Limnonectes hascheanus*, *Megophrys aceras*, *Kaloula pulchra*, *Microhyla butleri*, *Pulchrana laterimaculata* i *Polypedates discantus*. També vam registrar un nou anur a l'arxipèlag de Langkawi, *Pulchrana laterimaculata*, i dues espècies endèmiques de Malàisia, *Leptobrachium smithi* i *Limnonectes macrognathus*. Com a resultat d'aquest estudi, les espècies d'amfibis registrades a l'arxipèlag de Langkawi passen de 28 a 29.

Dades publicades a [GBIF](https://doi.org/10.15470/fodiow) (Doi:10.15470/fodiow)

Paraules clau: Bosc dipterocarp de terra baixa, Amfibis, Hàbitat, Diversitat, Langkawi, Malàisia peninsular

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Introduction

Lubuk Semilang Recreational Park is located at the base of Gunung Raya Forest Reserve, Langkawi, Kedah, Peninsular Malaysia. This forest covers 4,930 hectares and was declared a permanent forest in 1941 (Kedah Forestry Department, 2014). Lubuk Semilang Recreational Park is located beside Kampung Buku Malaysia and is approximately eight kilometres from the nearest town, Kuah. The stream at Lubuk Semilang, Sungai Korok, originates from the highest mountain of Langkawi, Gunung Raya (881 m a.s.l.). It flows into Sungai Kok, then into a larger stream, Sungai Melaka, before draining into the Straits of Malacca. In the Lubuk Semilang area, Sungai Korok is approximately two km long and it has a two-tier waterfall that is very popular for recreational and outdoor activities.

In the past, on herpetofauna surveys were conducted throughout Langkawi Archipelago by many researchers. Zimmerer (2004), Daicus et al. (2005), Ibrahim et al. (2006), Grismer et al. (2006), and Ehwan et al. (2016) had recorded 7, 9, 15, 24 and 11 amphibian species, respectively. At Pulau Singa Besar, 14 amphibian species were recorded by Lim et al. (2010), while at Lubuk Semilang, only 11 species of amphibians were recorded by Ibrahim et al. (2006) and Grismer et al. (2006). To date, 28 species of amphibians, including a single species of caecilian have been recorded from Langkawi Archipelago (Daicus et al., 2005; Lim et al., 2010; Ehwan et al., 2016).

At Lubuk Semilang, only a small area had been explored and studied by previous researchers. Many areas around Lubuk Semilang, such as small streams, wetlands, swamps, seasonal pools, ditches and upper parts of Sungai Korok, remain unexplored. The present research was thus carried out to document amphibian species that inhabit the lowland dipterocarp forest of Lubuk Semilang.

Material and methods

This research was conducted at the lowland dipterocarp forest of Lubuk Semilang Recreational Park, Langkawi Island (06° 21' 47.97" N – 99° 47' 30.17" E, elevation < 100 m a.s.l.) (fig. 1) Kedah, Peninsular Malaysia, between December 2018 and June 2019. Twenty-five consecutive visits were made. Samplings of amphibian species were performed at eight different habitat types: the lower, middle and upper part of Sungai Korok, small streams beside Mardi and Kg. Buku, marsh wetland, slow-moving stream, and road trail (fig. 2). Table 1 shows the characteristics of the habitat for each locality (see also fig. 3–6).

Tadpoles and egg clutches were collected between 10:00 and 13:00 h using a scoop net, and they were then placed in plastic containers. Amphibian individuals were captured between 20:00 and 23:00 h by means of a Visual Encounter Survey (VES), by hand or a scoop net, and with the help of headlights and flashlights. Two to three field members were involved in the surveys. Each live specimen was photographed in situ using a compact camera (Nikon COOLPIX L840) before being collected for identification.

Measurements taken for each individual were: weight (WT), tibia length (TL) (length of the outer surface of the flexed knee to the heel/tibiotarsal inflection), snout-vent length (SVL) (length from the tip of snout to posterior margin of the vent), and head width (HW) (the widest part of the head or angle of the jaws) (Watters et al., 2016). Measurements were made using electronic scales and a caliper.

Anuran species, including tadpoles, were identified based on their morphological characteristics, following by Smith (1930), Berry (1975), Inger et al. (2017), Norhayati et al. (2009), and Norhayati (2017). Taxonomic nomenclature was based on Frost (2019).

We recorded habitat characteristics, including the type of vegetation, river width, water current flow, and canopy-covering. Microhabitat characteristics, which include horizontal position, vertical position and substrates, were also determined (Heyer et al., 1994). Horizontal position refers to the shortest distance of the species from any water bodies (streams or ponds). Vertical position refers to subsurface on the exposed soil surface (on a rock or on the plant), while substrate refers to the surface area that the individual sits on at the time of capture (rock, vegetation, log, mineral soil or dead leaf) (Zainudin, 2009; Zainudin et al., 2017). We also recorded abiotic conditions such as humidity, temperature, and weather using AccuWeather application (android).

Selected anuran species were fixed in 10% formalin and stored in 7% ethanol. Specimens were tagged and deposited at the School of Pharmaceutical Sciences in Universiti Sains Malaysia (USM) for future reference. Tissue samples (from thigh muscles) of the preserved specimens were also collected, stored in 95% ethanol, and deposited at the same location for future molecular analysis. Samples were collected and sampled in accordance with legal regulations.

Results

We recorded a total of 18 amphibian species from 14 genera and 6 families in the lowland dipterocarp forest of Lubuk Semilang Recreational Park, Langkawi (table 2; [dataset published through GBIF](#), Doi: [10.15470/f0diow](https://doi.org/10.15470/f0diow)). This represents 62.1% of the amphibian species in Langkawi Archipelago. Ranid and dicroglossid frogs represent 27.8%, microhylid frogs 16.7%, bufonid toads and megophryid frogs 11.1%, and rhacophorid frogs 5.6% of total amphibian species (fig. 7). Most of the species were recorded at site 7 (20%), followed by site 1, 5 and 6 (16%), site 2 (13%), site 4 (7%), site 3 (8%), and site 8 (4%) (fig. 8). A ranid species, *Pulchrana laterimaculata*, is a new record for the Langkawi Archipelago. Several photos of amphibian species are shown in fig. 9–18. Amphibian species recorded in current and previous surveys are shown in table 3.



Fig. 1. Map of Langkawi Archipelago and location of the Lubuk Semilang Recreational Park in the Langkawi Island, Kedah, Peninsular Malaysia.

Fig. 1. Mapa del archipiélago de Langkawi y ubicación del parque recreativo Lubuk Semilang en la isla de Langkawi, Kedah, Malasia Peninsular.

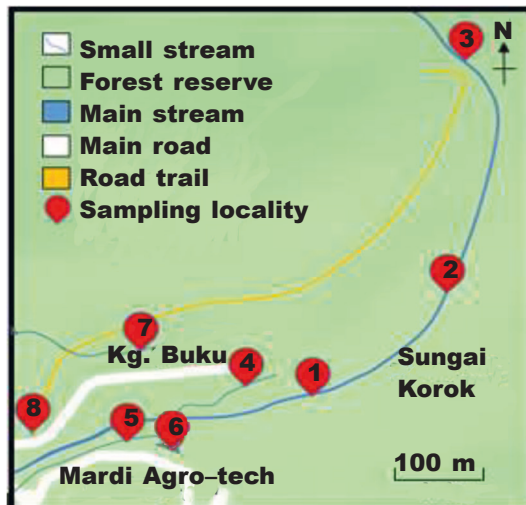


Fig. 2. Sampling sites. (For numbers of sampling sites, see table 1).

Fig. 2. Emplazamientos de muestreo. (Para los números de los emplazamientos, véase tabla 1).



Fig. 3–6. Photographs of sampling sites: 3, middle part of Sungai Korok; 4, marsh wetland/swamp; 5, slow-moving stream; 6, road trail.

Fig. 3–6. Fotografías de los emplazamientos de muestro, parte media de Sungai Korok; 4, zona pantanosa/humedal; 5, riachuelo de curso lento; 6, camino.

Species accounts

Family Bufonidae (2 species)

***Duttaphrynus melanostictus* (Schneider, 1799)**

This common Sunda toad was observed in the lower part of Sungai Korok and along small streams beside Kg. Buku and Mardi. They inhabit streams that have a high anthropogenic effect and usually perch on the bare soil of the sandy bank. On some nights, the calls of this toad can be heard from the lower part of Sungai Korok. This species can be identified by its stout body, blunt fingers, large round warts on its back, smaller warts on the side, and elongated parotoid glands (Berry, 1975).

***Phrynoidis asper* (Gravenhorst, 1829)**

19USM/LA/PA29: TL = 46 mm, SVL = 98 mm, HW = 30 mm

19USM/LA/PA30: TL = 42 mm, SVL = 85 mm, HW = 28 mm

19USM/LA/PA31: TL = 85 mm, SVL = 84 mm, HW = 25 mm

Temperature = 29–30 °C; relative humidity = 61–69 %.

This giant river toad can be spotted perched on large rocks, at midstream, and along the rocky bank at all parts of Sungai Korok, and also at a small, swift-flowing stream beside Mardi. During the daytime, they can be seen resting in cracks underneath large rocks. Sometimes they were found partially submerged underwater, beside the large rocks. The three specimens were collected at site 2 on 01/01/2019. They were identified by their large size, stout body, distinct tympanum, first finger slightly longer than second, large round warts on the back, and the roundish or subtriangular shape of prominent parotid glands (Berry, 1975).

Table 2. Amphibian species of Lubuk Semilang Recreational Park, Langkawi, Kedah: –, not recorded; V, voice; T, tadpole. (For the abbreviations of the sampling sites, see table 1).

Tabla 2. Especies de anfibios del Parque Recreativo Lubuk Semilang de Langkawi (Kedah): –, no registrada; V, voz; T, renacuajo. (Para las abreviaturas de los emplazamientos de muestreo, véase tabla 1).

Taxa	Sampling site							
	1	2	3	4	5	6	7	8
Family Bufonidae								
<i>Duttaphrynus melanostictus</i>	5	–	–	1	5	–	–	–
<i>Phrynoidis asper</i>	17	16	19	–	9	–	–	–
Family Dicroglossidae								
<i>Fejervarya limnocharis</i>	1	1	–	1	3	7	1	–
<i>Limnonectes blythii</i>	11	5	–	2	9	–	3	–
<i>Limnonectes hascheanus</i>	15	–	20	–	–	–	5	9
<i>Limnonectes macrognathus</i>	–	–	–	–	–	–	13	–
<i>Occidozyga martensii</i>	–	–	–	–	1	9	V	–
Family Megophryidae								
<i>Leptobrachium smithi</i>	3	T	1	–	1	–	T	–
<i>Megophrys aceras</i>	–	1	–	–	–	–	T	1
Family Microhylidae								
<i>Kaloula pulchra</i>	–	–	–	–	–	1	–	–
<i>Microhyla berdmorei</i>	–	–	–	–	–	1	5	–
<i>Microhyla butleri</i>	1	–	–	–	–	5	–	–
Family Ranidae								
<i>Chalcorana labialis</i>	9	15	–	30	10	2	2	–
<i>Hylarana erythraea</i>	–	–	–	–	–	7	–	–
<i>Pulchrana glandulosa</i>	–	–	–	V	1	1	V	–
<i>Pulchrana laterimaculata</i>	–	–	–	–	–	31	–	–
<i>Odorrana hosii</i>	–	3	24	–	–	–	–	–
Family Rhacophoridae								
<i>Polypedates discantus</i>	2	–	–	–	–	–	2	–
Number of species (18)	9	7	4	5	9	9	11	2

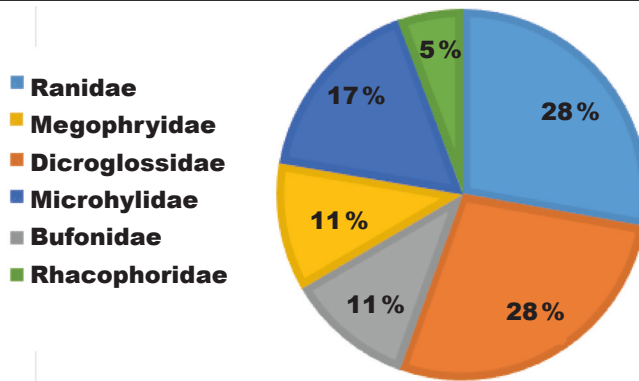


Fig. 7. Composition of amphibian families in Lubuk Semilang Recreational Park Langkawi, Kedah.

Fig. 7. Porcentajes de las distintas familias de anfibios del Parque Recreativo Lubuk Semilang de Langkawi (Kedah).

Family Dicroglossidae (5 species)

Fejervarya limnocharis (Gravenhorst, 1829)

This common grass frog was found at all sites of Lubuk Semilang Recreational Park except at the upper part of Sungai Korok and on the road trail. At every visit, they were found sitting on sand/soil along the stream banks and marsh wetlands. This species was identified by its grey to brownish colour with darker spots or patches, dark cross-bars on limbs, dark bars on lips, white ventral surface, distinct tympanum, slightly pointed snout, undilated blunt fingers, and pointed toes with undilated tips (Berry, 1975).

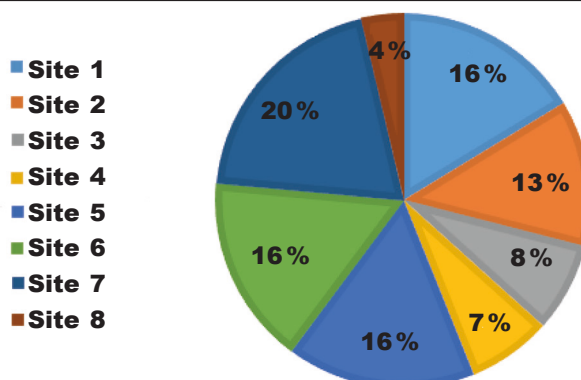


Fig. 8. Amphibian assemblages at each sampling site. (For abbreviations of sampling sites, see table 1).

Fig. 8. Porcentaje de anfibios registrado en cada emplazamiento de muestreo. (Para las abreviaturas de los emplazamientos de muestreo, véase tabla 1).



Fig. 9. *Limnonectes hascheanus*.

Fig. 9. *Limnonectes hascheanus*.



Fig. 10. *Limnonectes macrognathus*.

Fig. 10. *Limnonectes macrognathus*.



Fig. 11. *Occidozyga martensii*.

Fig. 11. *Occidozyga martensii*.



Fig. 12. *Leptobrachium smithi*.

Fig. 12. *Leptobrachium smithi*.



Fig. 13. *Megophrys aceras*.

Fig. 13. *Megophrys aceras*.



Fig. 14. *Microhyla berdmorei*.

Fig. 14. *Microhyla berdmorei*.

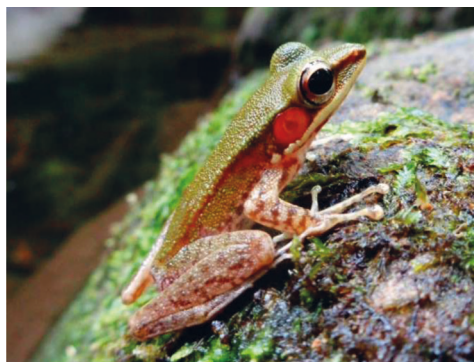


Fig. 15. *Chalcorana labialis*.

Fig. 15. *Chalcorana labialis*.



Fig. 16. *Odorrana hosii*.

Fig. 16. *Odorrana hosii*.



Fig. 17. *Pulchrana laterimaculata*.

Fig. 17. *Pulchrana laterimaculata*.



Fig. 18. *Polypedates discantus*.

Fig. 18. *Polypedates discantus*.

***Limnonectes blythii* (Boulenger, 1920)**

Blyth's river frog was frequently sighted at sites 1, 2, and 3 of Sungai Korok. Most were found sitting on medium-sized rocks midstream, on sand/soil of stream banks, or partially submerged in shallow streams. This species was recognized by its large size, head longer than broad, distinct tympanum, full webbing on toes and whitish–yellow ventral surface (Berry, 1975).

***Limnonectes hascheanus* (Stoliczka, 1870) (fig. 9)**

18USM/LA/LH03: TL = 12 mm, SVL = 22 mm, HW = 8 mm

19USM/LA/LH04: TL = 12 mm, SVL = 20 mm, HW = 8 mm

19USM/LA/LH05: TL = 13 mm, SVL = 20 mm, HW = 9 mm

Temperature = 28–30 °C; relative humidity = 78 %.

Three specimens of hill forest frog were collected on 28/12/2018 and 04/01/2019. All three individuals were collected at site 8, hiding among leaf litter, on the road trail, 6 m away from a permanent river. This species was observed abundantly along a stream beside the road

Table 3. Comparison of amphibian species in Lubuk Semilang Recreational Park Langkawi, Kedah: A, Ibrahim et al. (2006); B, Grismer et al. (2006); C, Daicus et al. (2005); CR, current research; –, not recorded; x, recorded.

Tabla 3. Comparación de las especies de anfibios del Parque Recreativo Lubuk Semilang de Langkawi (Kedah): A, Ibrahim et al. (2006); B, Grismer et al. (2006); C, Daicus et al. (2005); CR, este estudio; –, no registrada; x, registrada.

Taxa	A	B	C	CR
Family Bufonidae				
<i>Duttaphrynus melanostictus</i>	–	–	x	x
<i>Phrynooidis aspera</i>	x	–	x	x
Family Dicroglossidae				
<i>Fejervarya limnocharis</i>	–	–	–	x
<i>Limnonectes blythii</i>	x	–	x	x
<i>Limnonectes hascheanus</i>	–	–	–	x
<i>Limnonectes macrognathus</i>	–	x	–	x
<i>Limnonectes malesianus</i>	–	–	x	–
<i>Occidozyga lima</i>	x	–	–	–
<i>Occidozyga martensii</i>	–	x	–	x
Family Megophryidae				
<i>Leptobrachium smithi</i>	–	x	–	x
<i>Megophrys aceras</i>	–	–	–	x
Family Microhylidae				
<i>Kaloula pulchra</i>	–	–	–	x
<i>Microhyla berdmorei</i>	–	x	–	x
<i>Microhyla butleri</i>	–	–	–	x
<i>Microhyla heymonsi</i>	x	–	–	–
Family Ranidae				
<i>Chalcorana labialis</i>	–	–	x	x
<i>Hylarana erythraea</i>	x	–	x	x
<i>Pulchrana glandulosa</i>	x	–	–	x
<i>Pulchrana laterimaculata</i>	–	–	–	x
<i>Odorrana hosii</i>	–	–	x	x
Family Rhacophoridae				
<i>Polypedates discantus</i>	–	–	–	x
<i>Polypedates leucomystax</i>	x	–	–	–
Number of species (21)	7	4	7	18

trail and along Sungai Korok. It was identified by its small size, colour mostly pale brown, dark crossbar visible between the eyes, 'A' shaped mark between the shoulders, a blackish streak on each side of the head, distinct tympanum, short fingers and fingertips are dilated into small disks (Berry, 1975). Some orange and yellowish colour individuals were also seen.

***Limnonectes macrognathus* (Boulenger, 1917)** (fig. 10)

19USM/LA/LM04: TL = 26 mm, SVL = 50 mm, HW = 22 mm

19USM/LA/LM06: TL = 29 mm, SVL = 49 mm, HW = 25 mm

Temperature = 28 °C; relative humidity = 65 %.

Two large-headed river frogs were caught on the 24/01/2019. The first specimen was caught hiding among leaf litter, on the rocky bank at site 7 (slow-moving stream). The second specimen was captured while hiding under a large rock on a rocky bank at the same location. On 29/06/2019, the calls of this species could be heard at the same location. This frog was identified by its distinctive large broad head and visible, large tympanum for male, smaller head and smaller tympanum in females, dark bars on lips, irregular dark marking on dorsum, limbs with rounded tubercles, blunt fingers, first finger slightly longer than second, and smooth dorsum with longitudinal skin fold (Norhayati et al., 2009; Smith, 1930).

***Occidozyga martensii* (Peters, 1867)** (fig. 11)

18USM/LA/OM06: TL = 11 mm, SVL = 23mm, HW = 8 mm

19USM/LA/OM08: TL = 11 mm, SVL = 21mm, HW = 10 mm

19USM/LA/OM09: TL = 12 mm, SVL = 27mm, HW = 10 mm

Temperature = 27–30 °C; relative humidity = 65–69 %.

One Marten's oriental puddle frog was collected on 28/12/2018, sitting on the surface of leaf litter near a shallow stream beside Mardi (1–2 m width, 0.1–0.3 m depth). Another two individuals were caught partially submerged in watery mud and on the mud bank of marsh wetland on 20/01/2019. This frog was identified by its small, broad, oval-shaped head, hidden tympanum, brownish grey colouring on dorsal skin with dark round freckles and yellowish-white ventral skin (Norhayati, 2017).

Family Megophryidae (2 species)

***Leptobrachium smithi* (Matsui, Nabhitabhata and Panha, 1999)** (fig. 12)

19USM/LA/LS01: TL = 16 mm, SVL = 40 mm, HW = 19 mm

Temperature = 30 °C; relative humidity = 54 %.

An adult male Smith's litter frog was caught while calling under a large rock on a rocky bank, at the lower part of Sungai Korok on 28/01/2019. Their heavy-bodied tadpoles were also found grazing on the sandy bottom at the middle part of Sungai Korok and a small stream beside a road trail. This frog was identified by its wide head, wider than the body, large eyes, proportionally long arms, short legs, minimal webbing, and intense banded hind legs (Norhayati, 2017).

***Megophrys aceras* (Boulenger, 1903)** (fig. 13)

19USM/LA/XA01: TL = 25 mm, SVL = 57 mm, HW = 23 mm

19USM/LA/XA02: TL = 25 mm, SVL = 55 mm, HW = 21 mm

Temperature = 28–30 °C; relative humidity = 69–78 %.

On 01, 04/01/2019, an adult Perak spade-foot toad, was collected in the middle part of Sungai Korok and a juvenile was collected on a road trail. The adult was captured hiding under a large rock on a rocky bank. The juvenile was caught among leaf litter on the road, at least 50 m from the nearest stream. Their tadpoles were collected hiding among leaf litter sediment in a shallow slow-moving stream, beside the road trail (2–3 m width, 0.3 m depth). The frog was identified by its hidden tympanum, a triangular mark between the eyes, short dermal projection on top of eyelids, and limbs with dark crossbars (Norhayati et al., 2009).

Family Microhylidae (3 species)***Kaloula pulchra* (Gray, 1831)**

A single sub-adult banded bullfrog was observed on 17/06/2019, on soil bank approximately 0.5 m from marsh wetland. This species was identified by its stocky body, short limbs, hidden tympanum, wide head, rounded snout, expanded fingertips into truncate disks, toes with webbed base, smooth dorsal skin and no folds or ridges (Berry, 1975).

***Microhyla berdmorei* (Blyth, 1856)** (fig. 14)

19USM/LA/MB07: TL = 27 mm, SVL = 35 mm, HW = 15 mm

19USM/LA/MB11: TL = 27 mm, SVL = 37 mm, HW = 11 mm

Temperature = 28–30 °C; relative humidity = 65–73 %.

An adult Berdmore's narrow-mouthed frog was collected on 18/01/2019, hiding in a sand hole on a bank, approximately 1 m from a slow-moving stream, beside the road trail. On 24/01/2019, another calling male was caught in a sand hole on a sandy bank, at the same location. Choruses of other males, tadpoles, and a mating pair were also noted around site 7 (small moving stream). This species was recognized by its brownish or grey colour, hour-glass-shaped mark on its back, yellowish colouring on the ventral surface, hidden tympanum, and fully webbed toes (Berry, 1975).

***Microhyla butleri* (Boulenger, 1900)**

Many Butler's narrow-mouthed frogs were observed hiding among leaf litters at the lower part of Sungai Korok and marsh wetland, on 04/03/2019. This species was identified by its small, broad head, pointed obtuse snout, hidden tympanum, low ridges, small tubercles scattered on its skin, symmetrical dark brown, wavy markings on its back that extended down onto sides, and crossbars on the limbs (Berry, 1975).

Family Ranidae (5 species)***Chalcorana labialis* (Boulenger, 1887)** (fig. 15)

The white-lipped frog was observed abundantly at a small stream beside Kg. Buku. This species can be seen perched on the stem of the shrub as high as 1 m above ground. Calls of this frog can also be heard at the same location. They were recognized by their medium-sized body, conspicuous tympanum, pointed snout, creamy yellow or white upper lip, and round disks on tips of all fingers and toes (Norhayati et al., 2009).

***Hylarana erythraea* (Schlegel, 1837)**

A green paddy frog was seen partially submerged in the water of a marsh wetland. Another individual was spotted perched on a dead branch of a woody plant, 0.5 m above the ground, at the same location. This species was recognized by its distinct tympanum, pointed snout, slightly longer head than broad, bright green colour, yellowish dorsolateral fold, whitish upper lip, and ventral surface, tips of fingers dilated into disks, circum-marginal grooves, and webbing on toes that usually reached base on toe disks (Berry, 1975).

***Odorrana hosii* (Boulenger, 1891)** (fig. 16)

19USM/LA/OH01: TL = 50 mm, SVL = 80 mm, HW = 25 mm

19USM/LA/OH19: TL = 51 mm, SVL = 82 mm, HW = 25 mm

Temperature = 27–29 °C; relative humidity = 61–73 %.

Two adult females of this poisonous rock frog were collected on 01/01/2019 and 09/02/2019 at the middle and upper part of Sungai Korok, respectively. The specimens were found perched on large boulders on a rocky bank at midstream of fast-flowing current. Several other males were seen calling in the upper part of Sungai Korok. During the daytime, this species could be found hiding under large rocks on the rocky bank. It was identified by its

medium-sized body, pointed snout, head slightly longer than broad, distinct tympanum, and disks of all toes having broad webbing (Berry, 1975).

***Pulchrana glandulosa* (Boulenger, 1882)**

An adult rough-sided frog was observed sitting on the surface of leaf litter near a shallow stream beside Mardi on 29/04/2019. The calls of this frog were also heard along the stream banks and along the slow-moving stream (site 7). This species was recognized by its greyish-brown colour, dark cross-bars on limbs, small indistinct dark spots, rounded snout and dilated fingertips forming small disks (Berry, 1975).

***Pulchrana laterimaculata* (Barbour and Noble, 1916) (fig. 17)**

19USM/LA/PLT01: TL = 11 mm, SVL = 20 mm, HW = 7 mm

19USM/LA/PLT02: TL = 11 mm, SVL = 20 mm, HW = 7 mm

19USM/LA/PLT03: TL = 13 mm, SVL = 24 mm, HW = 8 mm

19USM/LA/PLT04: TL = 11 mm, SVL = 20 mm, HW = 7 mm

19USM/LA/PLT05: TL = 11 mm, SVL = 20 mm, HW = 7 mm

19USM/LA/PLT06: TL = 13 mm, SVL = 25 mm, HW = 8 mm

Temperature: 27–29 °C; relative humidity: 65–73 %.

Five juveniles of the spot-sided swamp frog and a sub-adult were collected as voucher specimens on 04/03/2019 at a marsh wetland/swamp. These frogs were seen perched on small leaves of herbaceous plants and among grasses around the swamp area. On 29/04/2019, the calls of this frog could be heard in the same area. This species was identified by its blackish-brown colour, distinct tympanum, slightly more than half-webbed toes, fingers without fringes or flaps of skin, white line on the upper lip visible from below the eye to tympanum and short ridges on the sides (Inger et al., 2017; Norhayati, 2017). This species is a new record for Langkawi Archipelago.

Family Rhacophoridae (1 species)

***Polypedates discantus* (Rujirawan, Stuart and Aowphol, 2013) (fig. 18)**

19USM/LA/PD03: TL = 26 mm, SVL = 50 mm, HW = 17 mm

Temperature = 30 °C; relative humidity = 61 %.

An adult Malayan slender tree frog was collected on 27/01/2019, perched on a branch of a dead tree, approximately 0.5 m above the ground, at the lower part of Sungai Korok. This species was recognized by its medium-sized, slender body, head longer than broad, shorter snout with pointy tip, yellowish-brown ventral surface, usually with small dark spots and mildly visible 'X' marking on its back, fingers basally webbed, and indistinct or no white spots on rear of the thigh (Rujirawan et al., 2013).

Discussion

A total of 18 species of amphibians was recorded at the lowland dipterocarp forest of Lubuk Semilang Recreational Park between December 2018 to June 2019, seven of which (*Fejervarya limnocharis*, *Limnonectes hascheanus*, *Megophrys aceras*, *Kaloula pulchra*, *Microhyla butleri*, *Pulchrana laterimaculata*, and *Polypedates discantus*) were recorded for the first time here. Furthermore, *Pulchrana laterimaculata*, was recorded for the first time within the Langkawi Archipelago. Four species, *Limnonectes malesianus*, *Occidozyga lima*, *Microhyla heymonsi*, and *Polypedates leucomystax*, previously recorded by Daicus et al. (2005) and Ibrahim et al. (2006), were absent in this study. The high number of newly recorded species may be due to factors such as the expansion of study areas, abiotic factors (weather, temperature, and humidity), habitat alteration, and habitat heterogeneity (McCaffery, 2010; Nur Amalina et al., 2017).

Only some of the species mentioned in the [dataset](#) published in [GBIF](#) are discussed in the text. Species mentioned in the text were less common (except for *P. asper*) and represent all the samples in the dataset. Additional data on these species is given because this information was lacking. Samples of *Pulchrana laterimaculata* (six juvenile voucher specimens) are mentioned because represent a new record of amphibian species within Langkawi Archipelago.

In Lubuk Semilang, accessibility to the area has increased significantly over time, enabling detection of more species than in previous studies. This study was conducted in both dry and wet seasons for a longer period, minimizing bias concerning detections of amphibian species in Lubuk Semilang. During a gap in research of over ten years, habitat alteration and heterogeneity significantly increased detection of some amphibian species and absence of others. These alterations and heterogeneity were mainly due to changes in–stream structure, weather patterns (especially precipitation), and human recreational activities that may provide niches, microhabitats, continuous foraging, and especially breeding habitat for these amphibians (McCaffery, 2010; Nur Amalina et al., 2017). We consider the absence of *Occidozyga lima* is due to misidentification with *Occidozyga martensii*. Several *Occidozyga* collected in Lubuk Semilang were morphologically similar to *Occidozyga martensii*, rather than to the *Occidozyga lima* specimen (LRCUKM–0179) from Datai that were deposited in Langkawi Research Centre, Universiti Kebangsaan Malaysia (UKM). This showed that *Occidozyga lima* can be found in Langkawi, but not in Lubuk Semilang. For a long time, *Polypedates discantus* was known as *Polypedates leucomystax*. It was only recently separated from *Polypedates leucomystax* complex species and named *Polypedates discantus* in a study by Rujirawan et al. (2013). From molecular studies, *Polypedates discantus* has uncorrected pairwise distances of 6.61–7.16% compared to its closest relative, *Polypedates leucomystax*. Morphological characteristics of *Polypedates discantus* are head skin that has not co–ossified with the skull, indistinct or absent white dots on the ventral part of the thigh skin, presence of round tubercle on the tibiotarsal articulation, and mildly visible 'X' marking on its back (Rujirawan et al., 2013). These morphological structures were similar to *Polypedates* found in Lubuk Semilang.

Pulchrana laterimaculata is a new record for the Langkawi Archipelago. Several *Pulchrana laterimaculata* juveniles and sub–adult individuals were found around marsh wetland/swamp, showing this species emerges from the nearby forest to use the swampy areas as their breeding site (Shahriza et al., 2011a, 2011b; Shahriza and Ibrahim, 2014). This finding has increased the number of amphibian species in the Langkawi Archipelago from 28 to 29 species.

The most common frog found in Lubuk Semilang, *Fejervarya limnocharis*, was identified in open areas at all the study sites except in the most disturbed sites (the upper part of Sungai Korok and forest trails), showing it is widely spread in both disturbed and less disturbed areas.

Several frog species, including *Hylarana erythraea*, *Kaloula pulchra*, *Microhyla butleri*, *Fejervarya limnocharis*, and *Duttaphrynus melanostictus*, are commensal species (Shahriza et al., 2011a, 2011b; Shahriza and Ibrahim, 2012, 2014, 2017). These species were often encountered at forest edges and disturbed areas with anthropogenic activities (Ibrahim et al., 2001; Tuen and Das, 2005; Norsham et al., 2005; Shahriza and Ibrahim, 2017) but rarely seen in forests (Inger and Stuebing, 1990). In Lubuk Semilang, these species can be found at sites 1, 4, 5 and 6 which are likely to be disturbed areas with anthropogenic activities. There are many activities here, including recreational activity and nature–based tourism. Alterations of local habitats provide various niches and microhabitats especially for the opportunists or generalist species (Nur Amalina et al., 2017). Pristine forest species or specialist species were replaced by species that adapted to secondary forest or generalist species (D'Cruze and Kumar, 2011). This explains why commensal species have high occurrences in Lubuk Semilang Recreational Park, especially at sites 1, 5 and 6.

The physical structure of streams determines different riparian frog species (Inger, 1969).

Limnonectes blythii, *Phrynomantis asper*, and *Chalcorana labialis* are riparian species and inhabit river banks (Berry, 1975; Inger and Stuebing, 1989; Shahriza et al., 2011a, 2011b). These frog species were sighted through the sampling period in and along Sungai Korok. The presence of clean water species such as *Odorrana hosii* and *Chalcorana labialis* indicates that sites 2 and 3 were still undisturbed and pristine. According to Ibrahim et al. (2012, 2013), is also considered a semi-disturbed species. In this study, *Chalcorana labialis* can be found in both disturbed and undisturbed areas. *Odorrana hosii* can be seen perched on rock boulders, either at midstream or rock banks of the middle and upper part of Sungai Korok. Both sites have moderate to fast stream currents, a suitable environment for this species (Ibrahim et al., 2008; Grismer, 2011; Shahriza and Ibrahim, 2012).

Sites 4, 5, 6 and 7 in Lubuk Semilang were considered ideal as breeding grounds for amphibians. The shallow slow-moving stream in site 5 was considered an active breeding ground for *Chalcorana labialis* due to the presence of egg clutches, tadpoles and several gravid females of this species. Juveniles of *Pulchrana laterimaculata* and *Pulchrana glandulosa* were present at site 6, indicating this area is the breeding ground for both species. The shallow slow-moving stream in site 7 was a breeding ground for *Microhyla berdmorei*, *Leptobranchium smithi*, *Megophrys aceras*, and *Limnonectes macrognathus*. Several egg clutches and an amplexus pair of *Microhyla berdmorei* were found there. Additionally, tadpoles of *Microhyla berdmorei*, *Leptobranchium smithi*, and *Megophrys aceras* were also sighted there. Mating calls of *Microhyla berdmorei*, *Pulchrana glandulosa*, *Occidozyga martensii* and *Limnonectes macrognathus* were heard at the same site.

According to Barnett (2005), wetlands, slow backwater off-channel streams, shallow ponds, and seasonal pools with a water depth of less than 0.5 meters become suitable breeding grounds for amphibians. Amphibians prefer shallow water to breed, generally due to the presence of fewer invertebrates, absence of fish predators, and water that is warmer and thus suitable for egg and larval development (Barnett, 2005). These types of environments can be found at sites 4, 5, 6 and 7 of Lubuk Semilang.

Forest frog species that inhabit the lowland dipterocarp forest of Lubuk Semilang were *Limnonectes hascheanus*, *Leptobranchium smithi*, *Megophrys aceras*, *Microhyla berdmorei*, and *Limnonectes macrognathus*. The presence of these species indicates some parts of Lubuk Semilang are still undisturbed or have a minimal disturbance. The presence of two Langkawi endemic frogs, *Leptobranchium smithi* and *Limnonectes macrognathus*, shows that Lubuk Semilang is an important site for amphibian species and should be fully protected. The survey on amphibian species in these areas is ongoing and many potential areas are yet to be explored.

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