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RESEARCH ARTICLE

Herpetofauna Diversity and Composition in Mak Jintan Peat Swamp Forest, North-Eastern Terengganu, Peninsular Malaysia: An Assessment With an Updated National Checklist: Amphibians and reptiles of peat swamp forest

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Abstract Peat swamp forests in Malaysia harbor diverse amphibian and reptile populations, yet these ecosystems remain understudied and undervalued in conservation efforts. This study presents the first assessment of amphibian and reptile diversity in Terengganu's peat swamp forests. The objectives of the study were to assess the diversity and composition of amphibians and reptiles at Mak Jintan peat swamp forest and to update the checklist of the amphibians and reptiles of the peat swamp forests of Peninsular Malaysia. A survey conducted in 2019 at Mak Jintan peat swamp forest employed Visual Encounter Survey (VES) and Acoustic Encounter Survey (AES) methods. We recorded 68 individuals comprising 15 amphibian species from five families and eight reptile species from eight families. Amphibian and reptiles' diversity were considered low with amphibians recorded H'= 2.355 and reptiles, H'= 1.726. An updated checklist for peninsular Malaysia's peat swamp forests now includes at least 129 species from 22 families. This research enhances our understanding of herpetofauna diversity in peninsular Malaysia's peat swamp forests and provides recommendations for their conservation.

Keywords: Amphibians, Belara Reserve Forest, peatland, reptiles, waterlogged soil, wetland

Introduction

Malaysia, one of 17 megadiverse countries globally, boasts a rich biodiversity supported by its tropical climate and varied topography [1, 2]. These diverse habitats, ranging from lowland to montane forests, harbour a wide array of herpetofauna - amphibians and reptiles collectively. Peat swamp forests, in particular, provide unique ecosystems that support specialized herpetofauna communities [3, 4]. Herpetofauna play crucial ecological roles in maintaining biodiversity within the middle tiers of the ecosystem's food web in both terrestrial and aquatic environments [5, 6]. They serve dual functions, as consumers of land and water-dwelling insects, and as food sources for various fish, bird, and mammal species [7, 8]. This positioning makes them integral to the flow of energy and nutrients throughout the ecosystem. [9, 10]. Amphibians facilitate nutrient exchange between habitats and regulate primary production in aquatic ecosystems [11], while reptiles serve as gene and nutrient transporters, with some larger species acting as ecosystem engineers [12].

Despite their ecological importance, tropical peat swamp forests remain understudied and undervalued in conservation efforts [13]. In Peninsular Malaysia, only 19% of amphibian species and 7% of reptile species are known to inhabit peat swamp forests [13]. These unique ecosystems, characterized by high water tables, oligotrophic peats and predominantly Dipterocarp vegetation serve as significant carbon sinks and provide habitats for diverse and threatened species adapted to acidic environments [2, 14, 15, 16]. While several herpetofauna studies have been conducted in Malaysian peat swamp forests [17, 18, 19, 20], no specific research has focused on Terengganu's peat swamp ecosystems. This study aims to fill this knowledge gap by providing the first herpetofauna checklist for Mak Jintan peat swamp forest in Kuala Nerus, Terengganu. The site's proximity to human-modified landscapes, including oil palm plantations and paddy fields underscores the urgency of this research. This study also includes an analysis of herpetofauna species across various peat swamp forests in Peninsular Malaysia, providing insights into species composition and distribution patterns among these unique and often understudied habitats.

As sensitive bioindicators, particularly amphibians, herpetofauna can provide valuable insights into ecosystem health and environmental changes [21]. The findings from this pioneering study will not only contribute to our understanding of herpetofauna diversity in Terengganu's peat swamp forests but also inform long-term monitoring efforts and conservation strategies. By identifying potentially endemic or threatened species, this research will support targeted conservation actions that benefit both herpetofauna and the broader ecosystem.

Materials and Methods

Study site

The survey was conducted for five days in May 2019 at Mak Jintan tropical peat swamp forest, located in the north-eastern part of Terengganu, Malaysia (5°25'16.2"N, 102°55'46.2"E). The study site, adjacent to Belara Forest Reserve covers approximately 842 hectares and lies 11.3 km inland from the coast, straddling the boundary between Kuala Nerus and Setiu districts (Figure 1). The area experiences a seasonal climate with peak precipitation from October to February, exceeding 300 mm monthly. November receives the highest rainfall (nearly 1,200 mm) while June to September is relatively dry (below 200 mm), with June recording the lowest rainfall (less than 50 mm) [22]. During periods of extensive rainfall, the site becomes inaccessible due to flooding. The forest is characterized by trees exceeding 40 m in height, with diameter-at-breast-height (DBH) ranging from 40-50 cm. Dominant tree species include *Antisoptera* sp., *Shorea* sp., *Calophyllum sclerophyllum*, *Calophylum* sp., *Blumeondendron tokbrai*, *Durio carinatus*, *Gonostylus bancanus*, *Elateriospermum tapos* and *Syzgium* sp. The forest edge features *Macaranga pruinosa* and *M. gigantean*, while common understory species include *Pandanus helicopus* and *Nepenthes ampullaria*. The peat depth is approximately 2 m from the topsoil layers. The site shows only small-scale human activities (household-level timber collection and smallholder oil palm cultivation) without industrial-scale operations. The absence of major roads limits accessibility and consequently restricts disturbance intensity. The peatland area was not surrounded by extensive oil palm plantations or major roadways [22].

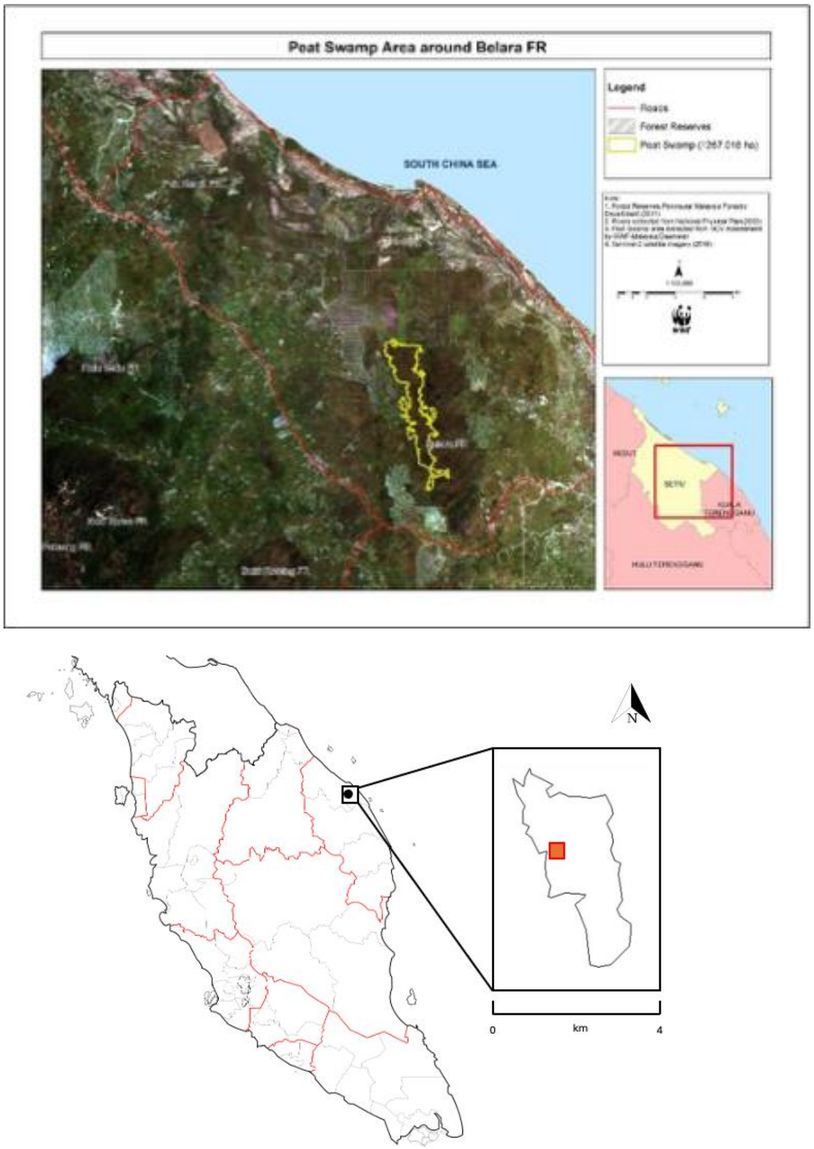

Figure 1. Location of Mak Jintan peat swamp forest in Terengganu, Malaysia. The study site (red box) is adjacent to Belara Forest Reserve and surrounded by paddy fields. (Source: WWF Malaysia)

Survey methods

Two complementary survey techniques were employed to comprehensively sample the herpetofauna community: Visual Encounter Survey (VES) and Acoustic Encounter Survey (AES). Visual Encounter Survey (VES) was conducted during three daily sessions: 9:00-12:00, 14:00-16:00 and 20:00-23:00. Five surveyors walked along 2 km of established routes or meandered through the site, thoroughly searching potential herpetofauna habitats. Night surveys utilized wide-beam headlights. Microhabitats such as tree bark, leaf litter, forest trails and damp areas were carefully examined [23]. Acoustic Encounter Survey (AES) was conducted concurrently with VES, focusing on vocally active male frogs. When frog calls were detected, surveyors gradually approached the source. Call cycles were recorded using a sound recorder or smartphone and compared to available frog call databases (e.g., https://amphibiaweb.org/lists/sound.shtml) for identification. Species were identified to the lowest possible taxonomic level using morphological characteristics and field guides [24, 25, 26, 27, 28]. Photographs were taken for reference before release.

Data analysis

Species abundance and richness were calculated using observational records. Diversity was measured using Shannon (H') and Simpson's (D) indices, with higher values indicating greater diversity. Species richness was assessed using Margalef (R1) and Menhinick (R2) indices, where higher values denote a greater number of species. Peilou's evenness index (J') and Buzas and Gibson's evenness index (E) were employed to determine species evenness at the community level. These indices range from 0 (low evenness) to 1 (high evenness) reflecting the distribution of individuals across species. Rank Abundance Curve (RACs), also known as Whittaker plots were used to illustrate species richness and evenness by measuring species abundance distribution. The x-axis represents species richness, while the y-axis represents abundance. Species ranks on the x-axis indicate dominance, intermediate status or rarity. RACs were plotted using PAST 4.04 software. Rarefaction curves were constructed to calculate expected species richness for a given number of individual samples [29]. This method allows for fair comparison of diversity across subsamples of equal size [30]. Rarefaction curves were plotted using EcoSim Professional software.

Species accumulation curves (SACs) were employed to estimate species richness and assess sampling completeness in the study area. SACs are widely used in ecological studies to extrapolate species richness beyond the sampled area and evaluate the adequacy of sampling efforts [31]. The curve plots the cumulative number of species detected against sampling effort, typically measured in sampling units or individuals. We considered sampling efforts adequate when the SAC approached an asymptote or showed a clear leveling-off trend, indicating that further sampling would likely yield few additional species. To generate the SACs, we used EstimateS software package [32]. The SACs were computed using 100 randomizations of sample order to smooth out the variation in species accumulation that can occur due to sampling order. We plotted separate SACs for amphibians and reptiles to compare sampling completeness between these two groups.

Results and Discussion

Our herpetofauna survey in Mak Jintan peat swamp forest, employing two different sampling techniques yielded 23 species represented by 91 individuals, comprising both amphibians (frogs and toads) and reptiles (skinks, lizards and snakes) (Table 1). We identified five amphibian families and eight reptile families. Among amphibians, *Ingerophrynus quadriporcatus* was the most abundant (16 individuals), followed by *Pulchrana glandulosa* (12 individuals) and *Occidozyga martensii* (eight individuals). *Limnonectes paramacrodon* and *Microhyla butleri* were the rarest, with only one individual each. Among amphibian families, Ranidae (four species) and Bufonidae (two species) were most abundant, each comprising 29% of the total individuals (Figure 2a). Rhacophoridae was the rarest amphibian family (3%), represented by a single species (*Polypedates leucomystax*). This prevalence of Ranidae is consistent with their diverse habitat preferences, including aquatic, semi-aquatic, terrestrial and arboreal niches [33]. Species such as *Chalcorana labialis* and *Pulchrana glandulosa* which prefer lowland and swampy habitats were well-represented, with their tadpoles typically found in shallow forest ponds [34, 35]. The abundance of Bufonidae can be attributed to their adaptive features such as thick, and dry skin which enables them to withstand the highly acidic conditions characteristic of peat swamp forests [36]. Conversely, the Rhacophoridae family, represented solely by *Polypedates leucomystax* showed the lowest abundance among amphibians. This species' resilience and adaptability to various modified habitats including urban areas may explain its presence despite the challenging peat swamp environment [37]. Notably, no species from the Megophryidae family were recorded. This absence may be due to the lack of permanent water bodies in the peat swamp forest which are crucial for species like *Megophrys nasuta* [38]. Additionally, fossorial species such as *Leptobrachium smithi* which depend on soil moisture may find the peat swamp conditions unsuitable [39].

Among reptiles, *Hemidactylus frenatus* was most abundant (seven individuals), followed by *Eutropis multifasciata* (six individuals) and *Calotes versicolor* (five individuals). All five snake species (*Coelognathus radiatus*, *Homalopsis buccata*, *Tropidolaemus wagleri*, *Ophiophagus hannah*, and *Malayopython reticulatus*) were rare, with only one individual each recorded. Among reptile families, lizards from the order Squamata were predominant with the Gekkonidae family showing the highest abundance (one species, 31%), followed by Scincidae (one species, 27%) (Figure 2b). The five snake families (Colubridae, Elapidae, Homalopsidae, Pythonidae and Viperidae) were equally rare, each represented by a single species and individual (4% each). This dominance of Gekkonidae can be explained by the high density of trees and multiple canopy levels in the Mak Jintan peat swamp forest [22], providing ample basking opportunities for thermoregulation [10]. The Scincidae family ranked second in abundance among reptiles, likely benefiting from the dry season survey conditions, which allowed ground-dwelling skinks to move freely on the forest floor. The abundance of insects during this period may have also favored species like *Eutropis multifasciata* [40]. Snake species showed the lowest abundance, with only one individual per species recorded across five families. This low representation may be due to the moist peat swamp environment, as snakes generally prefer drier areas with low humidity [10, 22]. However, some species like *Ophiophagus hannah* possess adaptations such as thick and dry scales that enable them to survive in the acidic peat swamp environment [10].

Regarding conservation status, *Kalophrynus limbooliati* has most recently been classified as Near Threatened by the IUCN Red List of Threatened Species in 2020. Although logging activities in the lowland forest and oil palm plantations have fragmented the habitat, this amphibian species is primarily found in protected areas, and its forest habitat currently faces no threats (Malaysia Red List Assessment Workshop, January 2018). *Ophiophagus hannah* was the only reptile species recorded in this study classified as Vulnerable by the IUCN Red List of Threatened Species. This status was last assessed in 2011, indicating that the species faces a high risk of extinction in the wild in the medium-term future. Population sizes in Peninsular Malaysia are reportedly small (L. Grismer pers. comm. 2011). The main threats to *O. hannah* populations include habitat loss and degradation, human persecution, overexploitation and international pet trade [41]. The oldest IUCN Red List assessments for species found in this study date back to 2004, including *Microhyla heymonsi*, *Occidozyga martensii*, and *Limnonectes paramacrodon*. The most recent assessments (2021) were for *Hemidactylus frenatus* and *Calotes versicolor*.

The rank abundance curves for amphibians showed less steepness than those for reptiles, indicating higher evenness among amphibian species (Figure 3). The gradient of the rank abundance curve reflects species evenness in the community ([42]. Steep gradients reveal dominance by a few reptile species with high abundances, indicating low evenness in the community structure. In contrast, shallow gradients demonstrate more uniform abundances across amphibian species, representing high community evenness where species are more equitably distributed. Individual-based rarefaction curves were used to compare species richness between amphibians and reptiles (Figure 4). The non-overlapping 95% confidence intervals suggest a significant difference in species richness between the two groups. Overall, amphibians (15 species) exhibited higher species richness compared to reptiles (8 species) in the Mak Jintan peat swamp forest. This disparity can be attributed to the presence of water bodies in the peat swamp forest which are crucial for amphibian life cycles [4]. For instance, *Ingerophrynus quadriporcatus* thrives near freshwater bodies in peat swamp forests, with high abundances of their tadpoles in shallow water [43]. Conversely, the moist forest floor conditions may limit reptile populations as they prefer hotter and drier areas for basking and thermoregulation [10,22]. Species accumulation curves (SAC) for both amphibians and reptiles showed increasing trends without reaching asymptotes, indicating that sampling efforts were not exhaustive for either group (Figure 5). The steepness of SAC reflects the rate of species discovery relative to sampling effort. Steeper slopes of the reptile's SAC indicate rapid species accumulation, suggesting either high local species richness, sampling efficiency, habitat heterogeneity or insufficient sampling effort to reach asymptotic species richness ([44, 45]. This pattern implies that additional sampling efforts could yield more species, particularly for reptiles [46,47,48]. The resulting curves provided insights into the effectiveness of our sampling strategy and the potential for discovering additional species with increased sampling effort.

Diversity indices (Table 2) revealed low diversity for amphibians (Shannon-Wiener index H' = 2.356; Simpson's index D = 0.857) and very low for reptiles (H' = 1.726; D = 0.783) [49]. Species richness was greater for amphibians (Margalef's index R1 = 3.318; Menhinick's index R2 = 1.819) than reptiles (R1 = 2.233; R2 = 1.688). Amphibians also exhibited higher species evenness (Pielou's evenness index J' = 0.87; Equitability index E = 0.703) than reptiles (J' = 0.83; E = 0.702).

Table 1. Observational records of amphibians and reptiles of Mak Jintan peat swamp forest with the IUCN Red List of Threatened Species status and the year papers were published.

No.	Family	Species Name	Common Name	Abundance	IUCN Red List Status
	Amphibians				
1	Bufonidae	*Duttaphrynus melanostictus*, Schneider, 1799	Asian common toad	4	Least Concern
2		*Ingerophrynus quadriporcatus*, Boulenger, 1887	Swamp toad	16	Least Concern
3	Dicroglossidae	*Fejervarya limnocharis*, Gravenhorst, 1829	Grass frog	6	Least Concern
4		*Fejervarya cancrivora*, Gravenhorst, 1829	Crab-eating frog	2	Least Concern
5		*Limnonectes paramacrodon*, Inger, 1966	Peat swamp frog	1	Least Concern
6		*Occidozyga martensii*, Peters, 1867	Marten's puddle frog	8	Least Concern
7	Microhylidae	*Microhyla butleri*, Boulenger, 1900	Butler's narrow-mouthed frog	1	Least Concern
8		*Microhyla heymonsi*, Vogt, 1911	Dark-sided narrow-mouth frog	2	Least Concern
9		*Microhyla fissipes*, Boulenger, 1884	Ornate narrow-	5	Least Concern

			mouthed frog		
10		*Kalophrynus limbooliati*, Mitsui, Nishikawa, Belabut, Norhayati & Yong, 2012	Lim Boo Liat's sticky frog	2	Near Threatened
11	Ranidae	*Amnirana nicobariensis*, Stoliczka, 1870	Nicobar frog	2	Least Concern
12		*Chalcorana labialis*, Boulenger, 1887	White-lipped frog	4	Least Concern
13		*Hylarana erythraea*, Schlegel, 1837	Common green frog	2	Least Concern
14		*Pulchrana glandulosa*, Boulenger, 1882	Rough-sided frog	12	Least Concern
15	Rhacophoridae	*Polypedates leucomystax*, Gravenhorst, 1829	Four-lined tree frog	2	Least Concern
	Reptiles				
16	Agamidae	*Calotes versicolor*, Daudin, 1802	Oriental garden lizard	5	Least Concern
17	Colubridae	*Coelognathus radiatus*, Boie, 1827	Radiated ratsnake	1	Least Concern
18	Elapidae	*Ophiophagus hannah*, Cantor, 1836	King cobra	1	Vulnerable
19	Gekkonidae	*Hemidactylus frenatus*, Duméril & Bibron, 1836	Spiny-tailed house gecko	7	Least Concern
20	Homalopsidae	*Homalopsis buccata*, Linnaeus, 1758	Puff-faced water snake	1	Least Concern
21	Pythonidae	*Malayopython reticulatus*, Schneider, 1801	Reticulated python	1	Least Concern
22	Scincidae	*Eutropis multifasciata*, Kuhl, 1820	Many-lined sun skink	6	Least Concern
23	Viperidae	*Tropidolaemus wagleri*, Boie, 1827	Temple pitviper	1	Least Concern

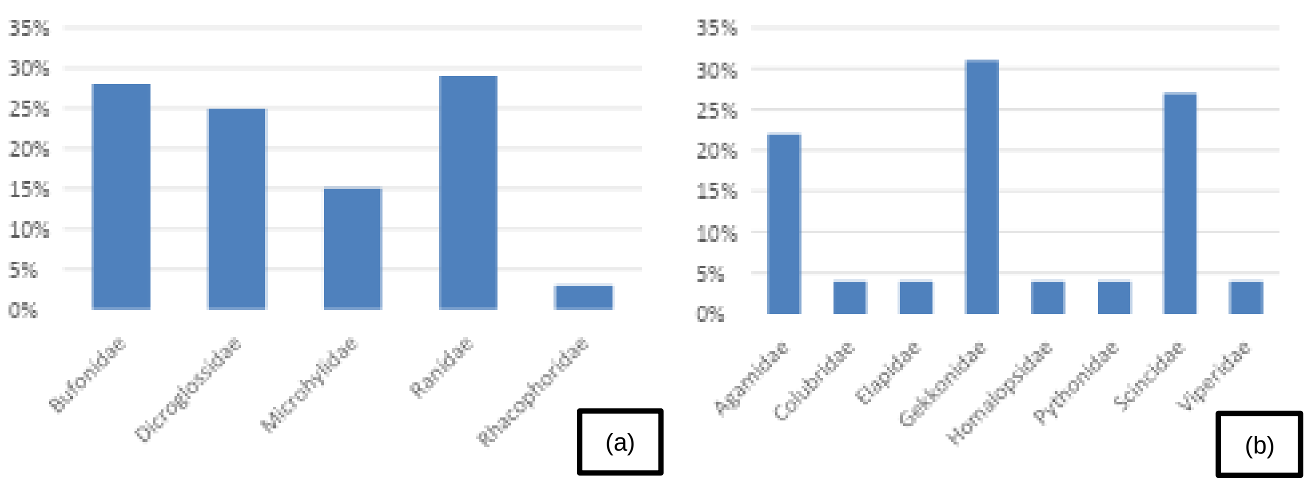

Figure 2. Relative abundance of (a) amphibian and (b) reptile families in the Mak Jintan peat swamp forest.

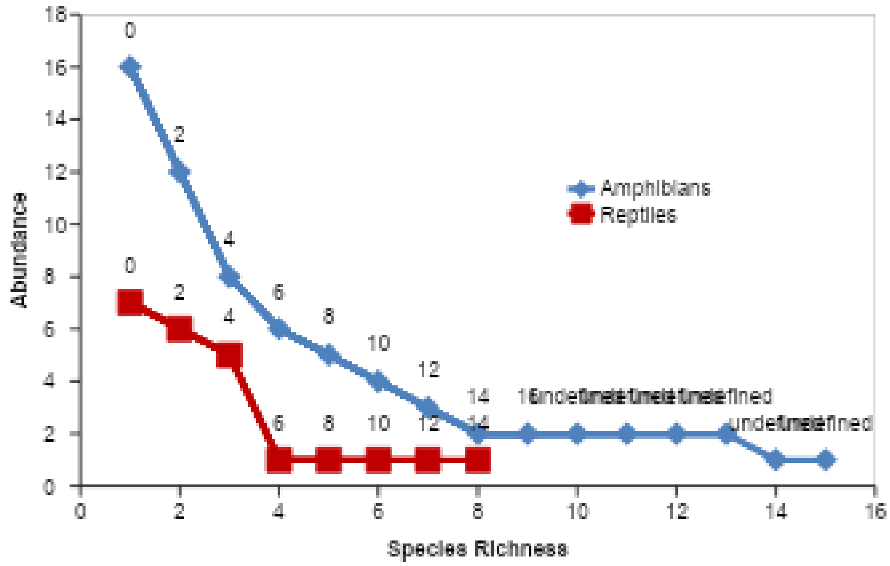

Figure 3. The rank abundance curve of amphibians and reptiles at Mak Jintan peat swamp forest. IQ: *Ingerophrynus quaadriporcatus*; PG: *Pulchrana glandulosa*; OM: *Occidozyga martensii*; FL: *Fejervarya limnocharis*; MF: *Microhyla fissipes*; CL: *Chalcorana labialis*; DM: *Duttaphrynus melanostictus*; MH: *Microhyla heymonsi*; KL: *Kalophrynus limbooliati*; FC: *Fejervarya cancrivora*; AN: *Amnirana nicobariensis*; HE: *Hylarana erythraea*; PL: *Polypedates leucomystax*; MB: *Microhyla butleri*; LP: *Limnonectes paramacrodon*; HF: *Hemidactylus frenatus*; EM: *Eutropis multifasciata*; CV: *Calotes versicolor*; CR: *Coelognathus radiatus*; HB: *Homalopsis buccata*; TW: *Tropidolaemus wagleri*; OH: *Ophiophagus hannah* and MR: *Malayopython reticulatus*.

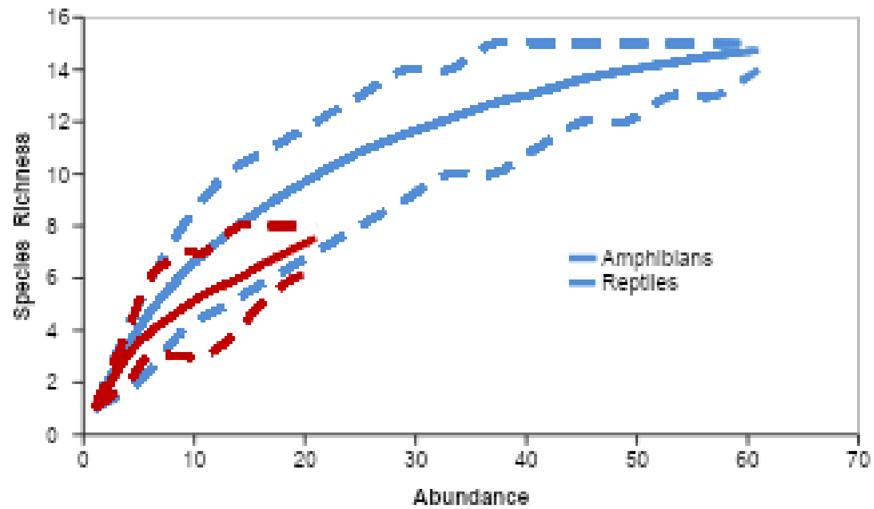

Figure 4. The rarefaction curve of amphibians and reptiles at Mak Jintan peat swamp forest. The broken line indicates the 95% confidence interval of the curve.

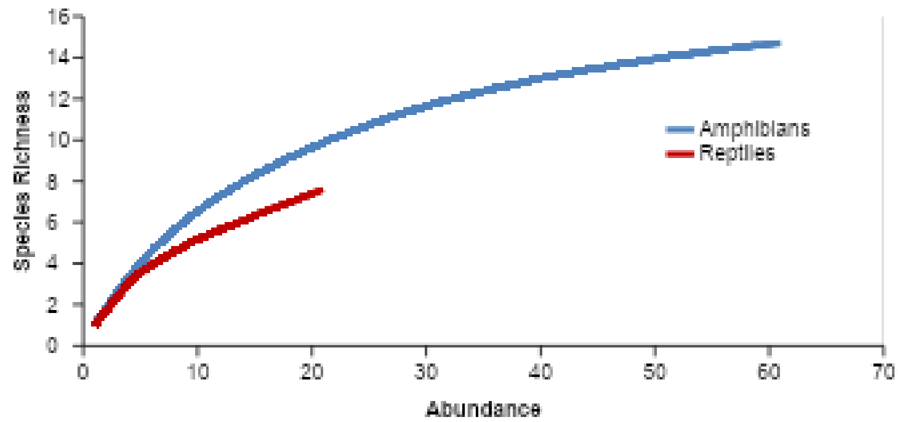

Figure 5. Species accumulation curves (SAC) for amphibians and reptiles in Mak Jintan peat swamp forest.

Table 2. The diversity indices of amphibians and reptiles at Mak Jintan peat swamp forest.

	Diversity Indices	Amphibians	Reptiles
Species Diversity	Shannon Index (H')	2.355	1.726
	Simpson Index (D)	0.875	0.783
Species Richness	Margalef Index (R_1)	3.318	2.233
	Menhinick Index (R_2)	1.819	1.668
Species Evenness	Peilou Index (J')	0.870	0.830
	Buzas and Gibson Index (E)	0.703	0.702

Species checklist of amphibians and reptiles in peat swamp forests of peninsular Malaysia

Analysis of herpetofauna species across various peat swamp forests in Peninsular Malaysia (**Table 3**) revealed distinct patterns of distribution. South-east Pahang peat swamp forest harbored five exclusive species, including *Kurixalus appendiculatus* and *Acrochordus javanicus*. Tasek Bera Ramsar Site exhibited the highest exclusivity with 28 unique species such as *Megophrys nasuta* and *Nanohyla petrigena*. Kuala Langat North Forest Reserve uniquely hosted *Calotes emma*, while Gunung Panti Forest Reserve, Johor contained 26 exclusive species including *Parias hageni* and *Cyrtodactylus pantiensis*. Mak Jintan peat swamp forest uniquely supported *Kalophrynus limbooliati* and *Microhyla fissipes*. Contrastingly, *Fejervarya limnocharis* and *Polypedates leucomystax* were ubiquitous across all studied peat swamp habitats. The herpetofaunal composition of Mak Jintan closely resembled that of Tasek Bera Ramsar Site, sharing species such as *Ophiophagus hannah* and *Homalopsis buccata*. However, it differed notably from Kuala Langat North Forest Reserve, lacking species like *Fejervarya cancrivora* and *Microhyla heymonsi* that were present in Mak Jintan. These findings highlight the unique and varied herpetofaunal compositions across different peat swamp forests in Peninsular Malaysia, underscoring the importance of these habitats for biodiversity conservation.

Table 3. Checklist of amphibians and reptiles in peat swamp forests of Peninsular Malaysia.

No.	Family	Species	South-east Pahang , Pahang [50]	Tasek Bera Ramsar Site, Pahang [51]	Kuala Langat North Forest Reserve, Selangor [52]	Gunung Panti Forest Reserve, Johor [53]	Mak Jintan, Kuala Nerus, Terengganu (This study)
	Amphibians						
	Bufonidae	*Bufo kumquat*, Das & Lim, 2001	/	/			
1		*Duttaphrynus melanostictus*, Scneider, 1799	/	/		/	/
2		*Ingerohrynus parvus*, Boulenger 1887				/	
3		*Ingerophrynus quadriporcatus*, Boulenger, 1887		/		/	/
4		*Phrynoidis asper*, Gravenhorst, 1829		/		/	
5		*Pseudobufo subasper*, Tschudi, 1838	/	/			
6	Dicroglossidae	*Fejervarya cancrivora*, Gravenhorst, 1829	/	/			/
7		*Fejervarya limnocharis*, Gravenhorst, 1829	/	/	/	/	/
8		*Limnonectes blythii*, Boulenger 1920		/		/	
9		*Limnonectes khasianus*, Anderson, 1871		/			
10		*Limnonectes malesianus*, Kiew, 1984		/		/	
11		*Limnonectes paramacrodon*, Inger, 1966	/	/		/	/
12		*Occidozyga laevis*, Günther, 1858				/	
13		*Occidozyga martensii*, Peters, 1867				/	/
14	Megophryidae	*Leptobrachium hendricksoni*, Taylor, 1962		/		/	
15		*Leptobrachium nigrops*, Berry & Hendrickson, 1963	/	/		/	
16		*Megophrys nasuta*, Schlegel, 1858		/			
17	Microhylidae	*Kaloula baleata*, Müller, 1836	/			/	
18		*Kaloula pulchra*, Gray, 1831		/		/	
19		*Kalophrynus limbooliati*, Mitsui, Nishikawa, Belabut, Norhayati & Yong, 2012					/
20		*Kalophrynus palmatissimus*, Kiew, 1984		/		/	
21		*Kalophrynus pleurostigma*, Tschudi, 1838				/	
22		*Microhyla berdmorei*, Blyth, 1856		/			
23		*Microhyla butleri*, Boulenger, 1900	/	/			/
24		*Microhyla heymonsi*, Vogt, 1911		/		/	/
25		*Microhyla mantheyi*, Parker, 1928				/	
26		*Microhyla fissipes*, Boulenger, 1884					/
27		*Microhyla palmipes*, Boulenger, 1897				/	
28		*Nanohyla petrigena*, Inger & Frongner, 1979		/			
29		*Micryletta inornata*, Boulenger, 1890		/		/	
30	Ranidae	*Amnirana nicobariensis*, Stoliczka, 1870		/		/	/

31		*Chalcorana labialis*, Boulenger, 1887		/	/		/
32		*Chalcorana raniceps*, Peters, 1871	/			/	
33		*Hylarana erythraea*, Schlegel, 1837	/	/	/	/	
34		*Hylarana laterimaculata*, Barbour & Noble, 1916				/	/
35		*Hylarana picturata*, Boulenger, 1920				/	
36		*Odorrana hosii*, Boulenger, 1891		/		/	
37		*Pulchrana glandulosa*, Boulenger, 1882		/	/	/	
38		*Hylarana baramica*, Boettger, 1903	/	/		/	
39		*Humerana miopus*, Boulenger, 1918	/	/			/
40	Rhacophoridae	*Buergeria buergeri*, Temminck & Schlegel, 1838		/			
41		*Kurixalus appendiculatus*, Günther, 1858	/				
42		*Nyctixalus pictus*, Peters, 1871		/		/	
43		*Polypedates colletti*, Boulenger, 1890	/	/		/	
44		*Polypedates leucomystax*, Gravenhorst, 1829	/	/	/	/	/
45		*Polypedates macrotis*, Boulenger, 1891	/			/	
46		*Rhacophorus cyanopunctatus*, Manthey & Steiof, 1998				/	
47		*Rhacophorus nigropalmatus*, Boulenger, 1895				/	
48		*Rhacophorus tunkui*, Kiew, 1987				/	
49		*Theloderma licin*, McLeod & Norhayati, 2007				/	
	Reptiles						
50	Acrochordidae	*Acrochordus javanicus*, Hornstedt, 1787	/				
51	Agamidae	*Acanthosaura armata*, Hardwicke & Gray, 1827				/	
52		*Aphaniotis fusca*, Peters, 1864	/	/		/	
53		*Bronchocela cristatella*, Kuhl, 1820)		/		/	
54		*Calotes emma*, Gray, 1845			/		
55		*Calotes versicolor*, Daudin, 1802		/	/	/	/
56		*Draco formosus*, Boulenger, 1900		/		/	
57		*Draco maximus*, Boulenger, 1893		/			
58		*Draco melanopogon*, Boulenger, 1887		/		/	
59		*Draco punctatus*, Boulenger, 1900		/			
60		*Draco quinquefasciatus*, Hardwicke & Gray, 1827		/		/	
61		*Draco sumatranus*, Schlegel, 1844		/		/	
62		*Draco taeniopterus*, Günther, 1861		/			
63		*Draco volans*, Linnaeus, 1758		/			
64		*Gonocephalus belli*, Duméril & Bibron, 1837		/			
65		*Gonocephalus grandis*, Gray, 1845		/		/	
66		*Gonocephalus liogaster*, Günther, 1872		/			
67		*Leiolepis belliana*, Hardwicke & Gray, 1827	/				
68	Bataguridae	*Cyclemys dentata*, Gray, 1831				/	
69	Colubridae	*Ahaetulla mycterizans*, Linnaeus, 1758				/	

70		*Ahaetulla prasina*, Boie, 1827		/		
71		*Boiga dendrophila*, Boie, 1827	/	/	/	
72		*Boiga nigriceps*, Guenther, 1863	/	/		
73		*Calamaria lowi*, Boulenger, 1887			/	
74		*Chrysopelea ornate*, Shaw, 1802		/		
75		*Chrysopelea paradisi*, Boie, 1827		/		
76		*Coelognathus flavolineatus*, Schlegel, 1837			/	
77		*Coelognathus radiatus*, Boie, 1827	/			/
78		*Dendrelaphis formosus*, Boie, 1827		/	/	
79		*Dendrelaphis pictus*, Gmelin, 1789		/		
80		*Dendrelaphis striatus*, *Cohn*, 1905		/		
81		*Enhydris enhydris*, Schneider, 1799	/			
82		*Gonyosoma oxycephalum*, Boie, 1827		/		
83		*Rhabdophis flaviceps*, Duméril, Bibron & Duméril, 1854	/	/		
84		*Rhabdophis rhodomelas*, Boie, 1827		/	/	
85		*Oligodon signatus*, Günther, 1864			/	
86		*Ptyas korros*, Schlegel, 1837	/	/		
87		*Xenochrophis trianguligerus*, Boie, 1827			/	
88	Elapidae	*Bungarus candidus*, Linnaeus, 1758	/			
89		*Calliophis bivirgatus*, Boie, 1827		/		
90		*Calliophis intestinalis*, Laurenti, 1768		/	/	
91		*Naja sumatrana*, Müller, 1890		/		
92		*Ophiophagus hannah*, Cantor, 1836		/		/
93	Gekkonidae	*Cnemapsis kendallii*, Gray, 1845			/	
94		*Cyrtodactlus consobrinus*, Peters, 1871		/	/	
95		*Cyrtodactylus pantiensis*, Grismer et al., 2008			/	
96		*Cyrtodactylus quadrivirgatus*, Taylor, 1962	/		/	
97		*Cyrtodactylus semenanjungensis*, Grismer & Leong, 2005			/	
98		*Gehyra mutilata*, Wiegmann, 1834		/	/	
99		*Gekko monarchus* Duméril & Bibron, 1836		/	/	
100		*Gekko smithii*, Gray, 1842	/	/	/	
101		*Hemidactylus craspedatus*, Mocquard, 1890			/	
102		*Hemidactylus frenatus*, Duméril & Bibron, 1836		/	/	/
103		*Hemidactylus garnotii*, Duméril & Bibron, 1836		/		
104		*Hemidactylus platyurus*, Schneider, 1792		/	/	
105	Geomydidae	*Cuora amboinensis*, Daudin, 1801		/		
106		*Heosemys spinosa*, Gray, 1831		/		
107		*Orlitia borneensis*, Gray, 1873		/		
108		*Siebenrockiella crassicollis*, Gray, 1831		/		
109	Homalopsidae	*Enhydris enhydris*, Schneider, 1799		/		

110		*Homalopsis buccata*, Linnaeus, 1758		/			/
111		*Kualatahan pahangensis*, Tweedie, 1946		/			
112	Pythonidae	*Malayopython reticulatus*, Schneider, 1801		/	/	/	/
113		*Python curtus*, Schlegel, 1872		/			
114	Scincidae	*Dasia olivacea*, Gray 1839				/	
115		*Eutropis multifasciata*, Kuhl, 1820	/	/		/	/
116		*Eutropis rugifera*, Stoliczka, 1870				/	
117		*Lipinia vittigera*, Boulenger, 1894				/	
118		*Lygosoma bowringii*, Günther, 1864				/	
119	Testudinidae	*Manouria emys*, Schlegel & Müller, 1844		/			
120	Trionychidae	*Amyda cartilaginea*, Boddaert, 1770		/			
121		*Dogania subplana*, Geoffroy, 1809		/			
122		*Pelochelys cantorii*, Gray, 1864		/			
123	Typhilopidae	*Indotyphlops braminus*, Daudin, 1803		/			
124	Varanidae	*Varanus nebulosus*, Gray, 1831		/		/	
125		*Varanus salvator*, Laurenti, 1768	/	/		/	
126	Viperidae	*Parias hageni*, van Lidth de Jeude, 1886				/	
127		*Tropidolaemus wagleri*, Boie, 1827		/			/
128	Xenopeltidae	*Xenopeltis unicolor*, Reinwardt, 1827	/	/			

Conclusions

The herpetofaunal diversity of Mak Jintan peat swamp forest is low, reflecting species adaptations to its extreme acidic conditions (pH as low as 3.5) compared to secondary forests (pH ~5.5). Amphibians showed higher abundance and species richness than reptiles likely due to suitable ecological conditions for their life cycles. The presence of the vulnerable *Ophiophagus hannah* and *Kalophrynus limbooliati* underscores the need for conservation efforts. To preserve this ecosystem and its 21 recorded herpetofauna species, we recommend implementing effective zoning, raising stakeholder awareness, conducting more extensive surveys across seasons and microhabitats, employing additional sampling methods like drift-fenced pitfall traps, and expanding survey areas. The unique composition of peat swamp forests may harbor endemic species especially among amphibians, emphasizing the importance of protecting these ecosystems. Future research should focus on filling knowledge gaps, assessing unevaluated species and developing targeted conservation strategies to ensure the long-term survival of these specialized herpetofauna communities in the remaining lowland peat swamp forests.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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