CONSERVATION MALAYSIA
A Bulletin Supporting Plant and Animal Conservation in Malaysia
Issue No 32 (2020)
ISBN 1823-7975

FLOURISHING *Rhizophora* MANGROVE HYBRIDS ON PULAU BURUNG, PORT DICKSON

Ng Wei Lun (weilun.ng@xmu.edu.my)
China-ASEAN College of Marine Sciences, Xiamen University Malaysia, Sepang, Selangor

Aerial view of Pulau Burung taken from a watch tower constructed on the islet. The hybrid *R. x lamarckii* grows luxuriantly on both sides of the boardwalk.

Off the coast of the popular recreation beach Pantai Cahaya Negeri in Port Dickson, Negeri Sembilan, lies a small uninhabited island called Pulau Burung. The islet is populated with mangroves, mainly from the genus *Rhizophora*, alongside other mangrove genera such as *Bruguiera, Xylocarpus, Ceriops, Sonneratia, Avicennia,* and *Scyphiphora,* as well as common mangrove associate species such as *Hibiscus tiliaceus* and *Ipomea pes-caprae*. Three species of *Rhizophora* are commonly found in Malaysia – *R. apiculata, R. mucronata,* and *R. stylosa*; unlike other *Rhizophora*-dominated mangrove sites in Malaysia, however, Pulau Burung is dominated by *Rhizophora* hybrids.

Two sterile natural hybrids, one between *R. apiculata* and *R. mucronata* (i.e. *R.* × *annamalayana*) and another between *R. apiculata* and *R. stylosa* (i.e. *R.* × *lamarckii*) are formally recognised and described (Ragavan *et al*., 2017). While a third hybrid between *R. mucronata* and *R. stylosa* has long been speculated to exist, the high morphological similarity between the two species makes the identification of any such hybrid challenging.

In 1996, Dr. Chan Hung Tuck, formerly of FRIM, first reported the discovery of *R. x lamarckii* on Pulau Burung (Chan, 1996). Its hybrid identity has been confirmed via the genetic approach (Ng *et al*., 2013). However, flowers of this hybrid often develop abnormally (e.g. flowers abort before calyx lobes are fully open, or calyx lobes do not open normally) and are thought to be reproductively non-viable. Nonetheless, a quick assessment on species composition of the islet has shown *R. x lamarckii* to be the dominant taxon on Pulau Burung, suggesting active cross-species pollination between locally-growing *R. apiculata* and *R.*

Close-up view that shows intermediate characteristics of foliage and inflorescence of *R. x lamarckii*; leaves generally resemble that of *R. mucronata*/*R. stylosa*, while flowers resemble those of *R. apiculata*.

stylosa. Most *Rhizophora* mangrove stands in Peninsular Malaysia are made up of *R. apiculata* and/or *R. mucronata*, while *R. stylosa* is found only in restricted locations (Mohd Nasir & Safiah Yusmah, 2007); co-occurring *R. apiculata* and *R. stylosa* populations are rare. This makes Pulau Burung one of the very few sites in the world with three co-occurring *Rhizophora* species, as well as a thriving population of *R. x lamarckii*.

While analysing population genetic data of the *Rhizophora* individuals on Pulau Burung, possible hybrids between *R. mucronata* and *R. stylosa* were also unexpectedly discovered (Ng *et al*., 2013). Moreover, unlike the former two hybrids, these hybrids appear to consist of reciprocal and advanced generation hybrids (Ng & Szmidt, 2014) and have been observed to bear fruits that germinate into propagules. Hybrids are often seen as evolutionary dead-ends, especially if they are sterile like in the cases of *R.* × *annamalayana* and *R.* × *lamarckii*. The discovery of fertile hybrids between *R. mucronata* and *R. stylosa* thus brings up questions on the evolutionary potential of mangrove hybrids.

The above account shows that two types of *Rhizophora* hybrids flourish on Pulau Burung; surprisingly, *R. x annamalayana* has not been found growing there. The generally sandy/rocky substrate on Pulau Burung probably provides a more suitable habitat for *R. stylosa* (and possibly the hybrids) compared to *R. apiculata* or *R. mucronata* which appear to grow only in restricted parts of the islet (Mohd Nasir & Safiah Yusmah, 2007). Then again, the coexistence of two or more *Rhizophora* species, as well as the presence of suitable substrates, is no guarantee for a successful and thriving hybrid population. More extensive studies should be conducted to understand the "magic" of Pulau Burung that allows it to host such rare populations of *Rhizophora* hybrids.

Amidst the increased ease of access to the islet with the construction of boardwalks to and around the islet as part of the attractions at Pantai Cahaya Negeri, the mangroves growing on Pulau Burung should be better managed. Several recent visits to the islet have revealed that more than one mangrove replanting programme has been conducted on one side of the islet, with *R. mucronata* being the species of choice, although *R. mucronata* is hardly dominant there (Ng & Chan, 2012). This could partly be due to the fact that outside the flowering season, *R. x lamarckii* can easily be mistaken as *R. mucronata* as they are similar in terms of leaf shape and size.

Pulau Burung, as it is, seems to encourage and continue to host the growth of *Rhizophora* hybrids for reasons that are as yet unknown to us. Any actions that alter the species composition (e.g. introduction of new genotypes and opportunities/competition for pollination) and the original habitat (e.g. the clearing for the construction of the boardwalks or a bund along which the abovementioned replanting was conducted) could bring significant effects to the existing *Rhizophora* hybrid populations, and therefore should be closely monitored.

Acknowledgement

The author is grateful to Dr. Chan Hung Tuck for his guidance and initial introduction to the *Rhizophora* hybrids on Pulau Burung.

References

Chan HT. 1996. A note on the discovery of *Rhizophora x lamarckii* in Peninsular Malaysia. *Journal of Tropical Forest Science* 9(1): 128–130.

Mohd Nasir H & Safiah Yusmah MY. 2007. Distribution of *Rhizophora stylosa* in Peninsular Malaysia. *Journal of Tropical Forest Science* 19(1): 57–60.

Ng WL & Chan HT. 2012. Further observations on a natural *Rhizophora* hybrid population in Malaysia. *ISME/GLOMIS Electronic Journal* 10(1): 1–3.

Ng WL, Chan HT & Szmidt AE. 2013. Molecular identification of natural mangrove hybrids of *Rhizophora* in Peninsular Malaysia. *Tree Genetics & Genomes* 9: 1151–1160.

Ng WL & Szmidt AE. 2014. Introgressive hybridization in two Indo-West Pacific *Rhizophora* mangrove species, *R. mucronata* and *R. stylosa*. *Aquatic Botany* 120: 222–228.

Ragavan P, Zhou R, Ng WL, Rana TS, Mageswaran T, Mohan PM & Saxena A. 2017. Natural hybridization in mangroves – an overview. *Botanical Journal of the Linnean Society* 185: 208–224.

Exploring the flora of Gunung Pulai, Baling, Kedah

Rafidah AR (rafidahar@frim.gov.my), Ummul-Nazrah AR,
Siti-Eryani S, Kiew R, Imin K & Mohd-Hairul MA

The unique horseshoe-shaped limestone ridge of Baling Hill, viewed from the summit of Gunung Pulai.

Introduction

Baling Hill is the imposing and remarkably horseshoe-shaped limestone ridge that is a prominent landmark in Baling town, Kedah. It encompasses several peaks such as Gunung Pulai (southern end) and Gunung Baling (northern end) that stand at opposite ends of the ridge. In Kedah, the towering peak of Gunung Pulai (670 m) or the Green Pyramid as it is called locally, is the second highest mountain after Gunung Jerai (1200 m). The Pulai limestone is one of the oldest limestone formations in Peninsular Malaysia, estimated at about 450 million years old. Incidentally, Gunung Pulai, Kedah, should not be confused with another Gunung Pulai, located in Johor, which is a granite mountain with a completely different vegetation type, i.e. hill dipterocarp forest.

Part of Gunung Baling was for many years mined for its limestone, but now controversy has arisen with the proposed plan to quarry Gunung Pulai without a comprehensive biodiversity survey first being carried out. Gunung Pulai, surrounded by oil palm and rubber plantations, is important for several reasons: biodiversity, numerous caves, eco-tourism industry, scenic monument with its unique horseshoe-shape, and its archaeological potential. It is also known for its numerous underground cave ecosystems with outstanding stalactite and stalagmite formations. Twenty years ago, Yong (1989) reported that Baling Hill-Gunung Pulai has significant geological features and pointed out its potential as a nature monument for conservation in Peninsular Malaysia. Recent archaeological excavations conducted by the National Heritage Department in 2019 discovered interesting artefacts including pre-historic tools, pottery fragments and a midden of river snails dated around 17,000-years old. Nowadays, Gunung Pulai has become popular with thrill seekers who like to explore its amazing deep caverns and scale its precipitous jagged slopes. The splendid view and the serene beauty of the surrounding countryside from the summit entices many hikers to climb the rocky hill.

Vegetation of Gunung Pulai

Since 1920, Gunung Baling has been the site of several botanical collecting trips, for example, collections by Meh, Abdullah, EJH Corner, MS Kiah, CX Furtado, LE Teo and J Wyatt-Smith. In more recent times, the FRIM botany team made botanical collections from Gunung Baling in 2008. In contrast, Gunung Pulai is almost un-documented botanically. To rectify this, a botanical expedition to Gunung Pulai was carried out in November 2019 where we collected approximately 176 taxa in 147 genera and 63 families. Even though the visit was for just a few days, two species were identified as new, and another as a new record for Peninsular Malaysia.

The composition of species collected can elucidate the different floristic elements of the flora and the diversity of microhabitats occurring on Gunung Pulai. The northern floristic province, north of a line from Kangar in Peninsular Malaysia to Pattani in southern Thailand, is where equatorial rain forest is replaced by semi-evergreen forest due to the prevailing monsoon climate (Saw, 2010; Kiew & Saw, 2019). Although well south of Kangar, the flora of Gunung Pulai shows similarities with the limestone flora of the northern floristic province. Of particular interest are

A view of the Green Pyramid, Gunung Pulai, from the Baling main road.

species restricted to growing on limestone substrates as they are often rare and confined to a single hill or group of hills only.

The flora at the base of Gunung Pulai includes a lush abundance of species of herbs, shrubs and small to large trees. Notable among herbaceous plants are species that belong to the limestone element of the flora that are restricted to growing on limestone substrates, like *Epithema membranaceum*, *Microchirita involucrata* and *M. rupestris* (Gesneriaceae), the balsams, *Impatiens macrosepala* and *Impatiens* sp. nov. (Balsaminaceae), the ginger, *Boesenbergia curtisii* (Zingiberaceae) and the climber, *Megistostigma burmanicum* (Euphorbiaceae). The grass, *Oplimenus compositus*, the creeper *Tetrastigma* (Vitaceae) and *Selaginella delicatula* (Selaginellaceae) can also be observed growing at the base. Small trees like *Erismanthus obliquus* (Euphorbiaceae), *Micromelum minutum* (Rutaceae), *Orophea maculata* (Annonaceae) and *Trigonostemon aurantiacus* (Euphorbiaceae) add to the diversity and distinguish the limestone forest from the surrounding lowland forest. Two bamboo species are observed between the middle elevation to the summit, that is *Dendrocalamus dumosus* and *Schizostachyum* sp. *Dendrocalamus dumosus* is restricted to limestone forest, and has also been recorded from Pulau Langkawi and Gunung Baling. In 1937, Furtado collected an interesting rattan, *Calamus balingensis* from Gunung Baling. Unfortunately, neither *C. balingensis* nor the fan palm, *Licuala mirabilis*, both species endemic to Gunung Baling, were seen on Gunung Pulai. Further field trips are needed to search for both species.

The tree species on Gunung Pulai are mostly endemic or restricted to growing on limestone and/or are species typical of the northern floristic province being adapted to a monsoon climate. Species such as *Artocarpus gomezianus* (Moraceae), *Kleinhovia hospita* (Sterculiaceae) and *Tetrameles nudiflora* (Datiscaceae) are dominant in the forested area. *Tetrameles nudiflora*, locally known as *mengkundor*, is a large deciduous tree with huge white buttresses up to 7 m tall and 4 m wide. The species has been recorded on limestone from Gua Labua (Kedah), Merapoh (Pahang) and Gua Musang (Kelantan). *Kleinhovia hospita,* previously recorded from lowland and mangrove forest, had been recorded from Baling in 1925 but without details of its vegetation type. Observations from this field trip showed *K. hospita* is in fact a dominant tree at the base of Gunung Pulai. *Artocarpus gomezianus* or *tampang hitam*, a tree of coastal and lowland forests that has a wide distribution in Peninsular Malaysia, is recorded from limestone for the first time at Gunung Pulai.

Climbing the steep rocky path from the middle levels of Gunung Pulai to the summit, several very rare species are encountered. A small population of a new species of *Coleus* (Labiatae) grows below a wet cliff face, while *Sohmaea teres* (Leguminosae), a new record for Peninsular Malaysia, inhabits a scree shaded slope (Rafidah *et al*., 2020), and the very rare, tufted herb, *Vernonia curtisii* (Compositae) dominates the top of rugged and rocky cliffs. *Vernonia curtisii* is a northern species and was previously only recorded from Langkawi and Thailand. Higher up on the steep ridges, small trees such as *Helicteres hirsuta* (Sterculiaceae), *Orophea maculata* and *O. hirsuta* (both Annonaceae) are common, while shaded valleys are occupied by patches of *Pandanus irregularis* (Pandanaceae), a typical limestone species. A few populations of limestone specialists like *Cycas clivicola* (Cycadaceae), the cactus-like *Euphorbia* cf. *tirucalli* (Euphorbiaceae), *Ficus deltoidea* (Moraceae) and *Vitex siamica* (Labiatae) can be found on the path ascending to the summit.

During this trip, the team managed to "conquer" two peaks, i.e., Gunung Beirut (the peak below Gunung Pulai) and Gunung Pulai itself. These two peaks cap the precipitous rocky slope of the narrow ridge where a variety of limestone species like *Duplipetala pentanthera*, *Dioscorea* sp., *Hoya* sp., *Paraboea verticillata* and *Peperomia kotana*, as well as non-limestone species like *Adenia penangiana* and the hemi-parasite *Macrosolen cochinchinensis* grow. A small population of *Shorea roxburghii* (Dipterocarpaceae) or 'temak nipis', a component of the northern floristic province, recorded from Perlis and Kedah, grows on the scattered boulders, near the summit of Gunung Pulai. In 2016, an out-of-control fire due to human negligence burned almost 16 ha of the peak area of Gunung Pulai.

After the fire, the wild lemon grass, *Cymbopogon calcicola* (Graminae) flourished on the rugged summit. The peak and the sheer cliffs are currently dominated by rare epiphytic ferns, and a few orchids.

Conclusion

Exploration of flora on Gunung Pulai, even though brief, shows that this limestone hill is important as it harbours several species that are typical of the northern element of limestone flora as well as being home to rare species like *Dendrocalamus dumosus*, *Sohmaea teres* (a new record for Malaysia), several endemics such as *Cycas clivicola*, *Orophea maculata, Paraboea verticillata*, *Peperomia kotana*, and endangered species like the new *Coleus* and *Impatiens*. What is interesting is that these rare species had not previously been collected from Gunung Baling, while the Gunung Baling endemic rattan, *Calamus balingensis*, has not yet been found on Gunung Pulai. This remarkable geological formation is obviously holding many more secrets awaiting discovery. It is certainly a valuable site for biodiversity conservation and much work is needed to fill the knowledge gaps needed to balance conservation and development. Currently, the plans to quarry Gunung Pulai are under review while information on biodiversity, archaeology, pollution, and other resources are being collected.

The beautiful succulent *Impatiens macrosepala* (left), and tufted herb *Vernonia curtisii* (Compositae) are examples of species of the northern floristic province.

Microchirita rupestris is restricted to limestone habitats. On the shaded cliffs of Gunung Pulai, there are two colour forms of white (right) and pale purple (left); the white flower is quite rare.

Sohmaea teres (Leguminosae) is a new record for Peninsular Malaysia.

Orophea maculata (left) and *Orophea hirsuta* (right) are both limestone specialists.

Shorea roxburghii has a long petiole *c*. 2.5 cm long, elliptic-oblong leaves (left) and covered with velvety hairs underneath giving it a coppery tinge (right). It is sometimes planted as an ornamental tree in parks, and its relatively soft wood is used for making packing cases.

Acknowledgements

We would like to thank the guides, Kueh Hock Leng, Roshazliza Abdul Razak, Mohamad Tarmizi Abdul Aziz, Ismail Abd Rahman and Muhamad Nizam, for guiding us to the hills.

References

Kiew R & Saw LG. 2019. Corner's Riau Pocket and other phytogeographical provinces in Peninsular Malaysia. *Gardens' Bulletin Singapore* 71 (Suppl. 2): 23–28.

Rafidah AR, Ummul-Nazrah AR & Wan Syafiq WP. 2020. *Sohmaea teres* (Fabaceae), a new record for Peninsular Malaysia. *Gardens' Bulletin Singapore* 72 (1): 23–28.

Saw LG. 2010. Vegetation of Peninsular Malaysia. In: R Kiew, RCK Chung, LG Saw, E Soepardmo & PC Boyce. (eds) *Flora of Peninsular Malaysia*, ser. 2, vol. 1, pp. 21

Yong FSK. 1989. Conservation of geological features in Peninsular Malaysia. *Geoc. Soc. Malaysia Bulletin* 23: 157–197.

THE VENOMOUS SNAKE SPECIES MOST FREQUENTLY CAUSING INJURIES IN MALAYSIA FROM 2017 TO 2019

Nurfarhana-Hizan, H., Nur Hazwanie, A. H. & Ahmad Khaldun, I. (khaldun_ismail@yahoo.com)

Snakes are one of the important components in an ecosystem. They play a significant role as a predator, especially in biological control, to ensure the ecosystem remains in balance. According to Das (2010, 2012) and Ismail (2015), from about 140 land and freshwater snake species recorded, approximately 25% of them are known to be medically significant. Most of the reported snake related cases involved harm or injury to humans which could result in mortality, depending on the severity of the injury (Ismail, 2015). Almost all snakes avoid human contact, however, many have also adapted to the human habitat due to the encroachment of anthropogenic activities into their natural environment. This chance encounter or handling of snakes may lead to humans getting bitten or injured by snakes.

The terms "venom" and "venomous" refer to the biological use (functionality) of the oral product and has nothing to do with its effects on humans (Weinstein, 2015). Many of those who are not aware and not qualified in toxinology misunderstand the term as referring to the clinical effects of venom toxins on humans. The evolutionary process of venom production occurred before the existence of humans. Venom secretion and its delivery system evolved for active use in predation, digestion and defence against natural enemies (Mackessy, 2016). The effect of venom on humans may or may not be the same as its effects on the snakes' prey or natural enemies. This oral product is produced and delivered via a high pressure ("true" venom gland) or a low pressure (Duvernoy's gland) system, and both systems differ from the typical salivary glands. Venom can be delivered through fangs (enlarged specialized set of teeth, anteriorly or posteriorly) via injection, inoculation or spray. The toxic effect on the targeted body is called envenomation. Most venomous snakes are also medically significant with the potential to cause harm, danger or death to humans. However, there are a few venomous snake species that are not significantly dangerous to humans such as *Boiga melanota* and *Tropidolaemus wagleri*.

REMOTE ENVENOMATION CONSULTATION SERVICES (RECS)

- Was officially established in early 2012; is a 24hr 'on-call' consultation service and training provider, mainly but not exclusively, for healthcare professionals since 2010.
- Was developed to assist healthcare professionals at various levels of clinical management for bites/stings envenoming from venomous animals and poisoning from naturally occurring toxins.
- Originated in Malaysia and was initially made up of Emergency Physicians and members of Malaysian Society on Toxinology (MST) with a special interest in Clinical Toxinology.
- The main objective of RECS is to enhance a favourable patient outcome by optimizing and advocating appropriate treatment modalities at every level of clinical management.
- The efforts of RECS have made a huge impact on patient care, and is recognized and supported by MST and the Ministry of Health.

MYBIS TOXINOLOGY MODULE

- Collaboration between MyBIS and RECS was formed in 2017 to record all RECS consultation log into a systematic registry module.
- The process involved filing of individual cases into the digital recording system.
- Various information such as snake species and incident location can be tabulated and analysed.

In Malaysia, several snake species are equipped with venom, such as those belonging to the family Elapidae (e.g. cobras, king cobra, kraits, coral snakes and sea snakes), Viperidae (pit vipers) and a few in the family Natricidae (e.g. keelbacks). There are also some non-venomous snakes that are potentially dangerous to humans such

as the pythons. Some snake bite injuries can also lead to secondary wound infections (cellulitis and septicaemia), especially in individuals with poor immune status such as diabetics, the elderly and malnourished victims.

Snakebites and various related injuries from human-snake conflict have been recognised by the World Health Organisation (WHO) as one of the most neglected tropical diseases (WHO, 2016). This is frequently a serious problem especially in rural areas of developing tropical countries with poor infrastructure and health systems. Potential high risk groups are agricultural workers, fishermen, hunters, working children, people living in poorly constructed houses and those with limited access to education and healthcare who tend to be more significantly exposed to such environments. South and Southeast Asia were identified as having the highest snakebite incidence and mortality (Kasturiratne *et al*., 2008; WHO, 2019).

According to Remote Envenomation Consultancy Services (RECS), there were a total of 851 cases consulted to RECS in 2017, 1073 cases in 2018 and 1027 cases in 2019. Sarawak, Pahang and Perak were the top three states for total number of consultations with 600, 528 and 407 cases, respectively. Snake related injuries (SRI) are the commonest cause for RECS clinical toxinology consultation in Malaysia (Remote Envenomation Consultancy Services, 2012). Figure 1 shows the venomous snake species most frequently consulted to RECS for the three consecutive years. Consultation records in 2017 showed *Naja sumatrana* (Sumatran spitting cobra, *n*=51), *Naja kaouthia* (monocled cobra, *n*=35) and *Trimeresurus purpureomaculatus* (mangrove pit viper, *n*=27) as the top three species causing venomous snakebites (Figure 2). The number of cases for these three species continued to increase in 2018 with *N. sumatrana* being the highest (*n*=61), followed by *N. kaouthia* (*n*=36) and *T. purpureomaculatus* (*n*=34). These snakes belong to the Elapidae and Viperidae family. In 2019, *N. sumatrana* (*n*=59) remained as the highest, followed by *T. subannulatus* (*n*=38) and *T. purpureomaculatus* (*n*=25).

All of these snake species are commonly encountered in human dwellings where the SRI cases were mostly reported. Among all the elapids, *Naja* species were found to be the commonest cause for bite envenoming and posed the highest potential to cause morbidity and mortality. The Sumatran spitting cobra (*N. sumatrana*), also locally known as Equatorial spitting cobra or *Ular senduk sembur* is the most frequently encountered among the nine land elapid species in Malaysia. From 2017 to 2019 (Figure 2), a total of 171 SRI cases involving this species were documented. This cobra inhabits various types of

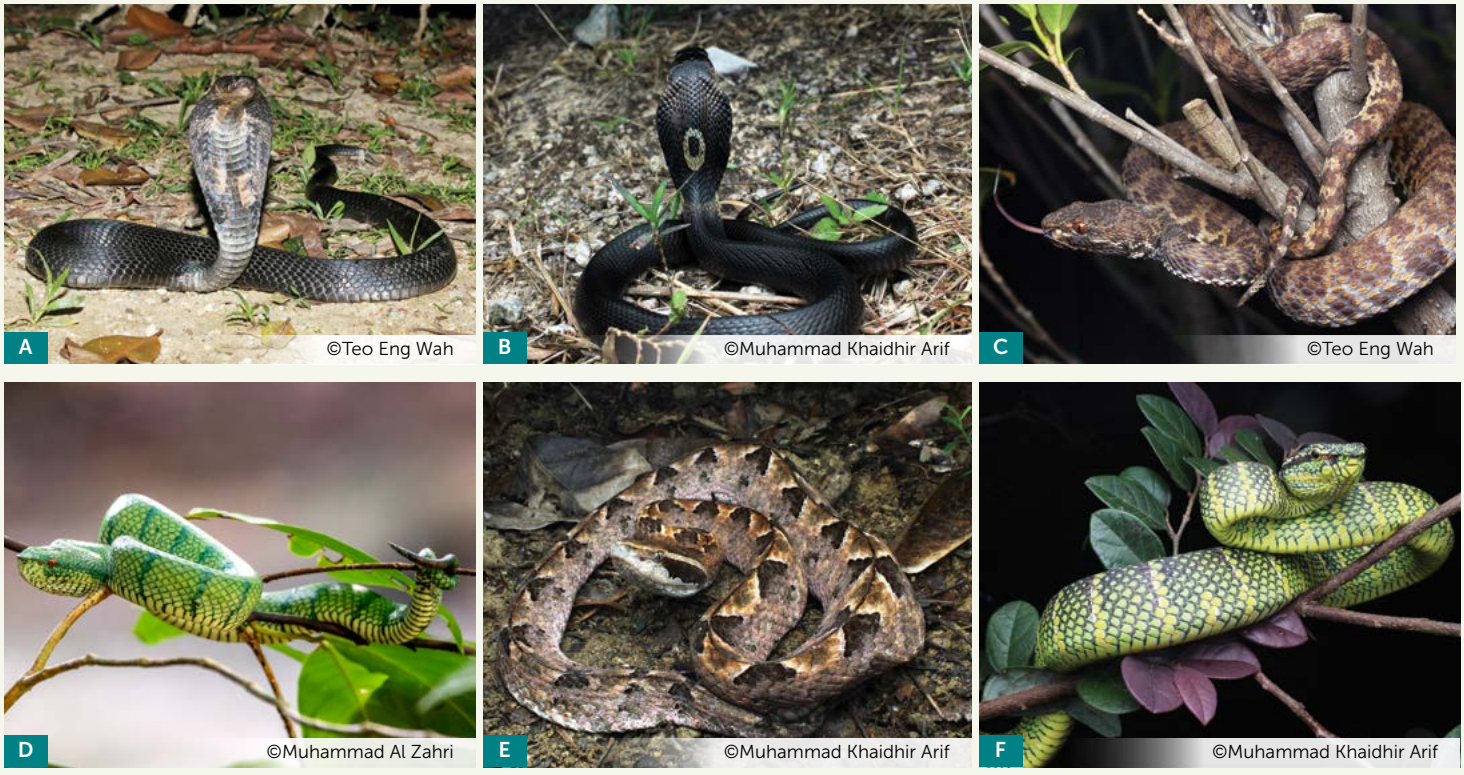

Figure 1. The six venomous snake species frequently causing bite envenoming injuries in Malaysia. **A**, *Naja sumatrana* (Sumatran spitting cobra); **B**, *Naja kaouthia* (monocled cobra); **C**, *Trimeresurus purpureomaculatus* (mangrove pit viper); **D**, *Tropidolaemus subannulatus* (Bornean keeled pit viper); **E**, *Calloselasma rhodostoma* (Malayan pit viper) ; **F,** *Tropidolaemus wagleri* (Wagler's pit viper).

habitats ranging from housing areas, fields, and plantations to forests. It is widely distributed and can be found in Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, islands in southern Philippines, and Borneo (Das *et al*., 2015). Another species from the same genus, the monocled cobra (*N. kaouthia*) accounted for the second highest SRI cases after *N. sumatrana*. It is widely distributed in Myanmar, Thailand and the northern states of Peninsular Malaysia where it inhabits the lowland forest and open environments such as agricultural fields, plantations and also human dwellings (Das, 2012).

It is important for the MyBIS Toxinology Module data repository to be continuously updated and analysed. Further studies on the distribution of snake species, the factors affecting their abundance and diversity, and their relationship with climate change and environmental factors are needed in Malaysia. Research and development on snake venom and optimisation of clinical management in Malaysia should be continued. The efforts to share verified information from experts in the field to counter archaic clinical practices, unproven treatment and myth busting need to be encouraged and supported. In addition, the public needs to be aware of the preventive measures against snakebites (safety seeking behaviour) and the appropriate first aid or treatment (health seeking behaviour) (Figure 3).

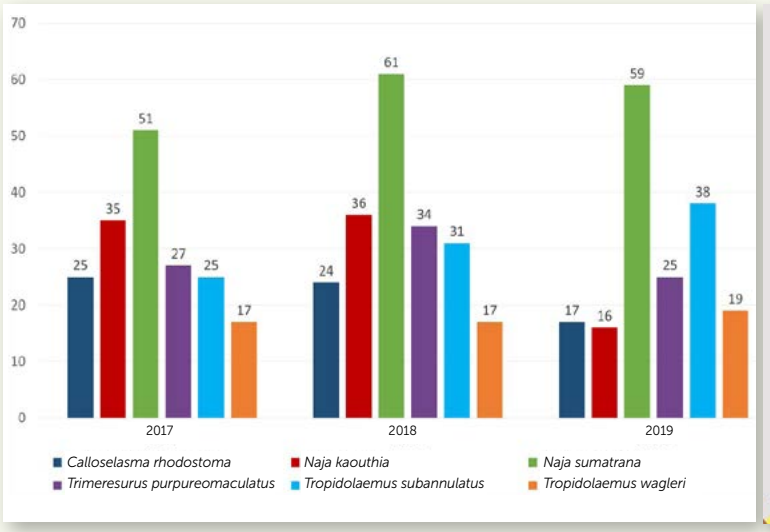

Figure 2. The six most common venomous snake species identified during consultations to Remote Envenomation Consultation Services from 2017 to 2019.

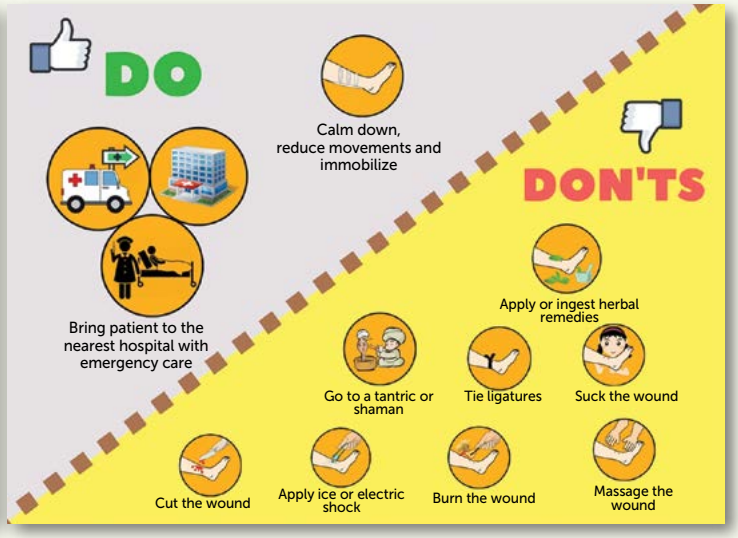

Figure 3. Snakebite: do's and don'ts adapted from Land Snakes of Medical Significance in Malaysia.

Acknowledgements:
We thank Dr Teo Eng Wah, Mr. Muhammad Khaidhir Arif bin Chek Mat @ Chemat, Mr. Muhammad Al Zahri bin Darus, Mr. Tan Kok Kiat and Mr. Abdul Razak bin Mohd Nor Rasid for their assistance in contributing ideas, photos and infographic design.

References

Das I. 2010. *A Field Guide to the Reptiles of South-east Asia*. London: New Holland Publishers (UK) Ltd.
Das I. 2012. *A Naturalist's Guide to the Snakes of South-east Asia: Malaysia, Singapore, Thailand, Myanmar, Borneo, Sumatra, Java and Bali*. John Beaufoy Publishing Ltd.
Das I, Ahmed N & Liat LB. 2015. Venomous Terrestrial Snakes of Malaysia: Their Identity and Biology. In: P Gopalakrishnakone, A Faiz, R Fernando, CA Gnanathasan, AG Habib & CC Yang (eds.) *Clinical Toxinology in Asia Pacific and Africa*, pp 53–69. Springer Netherlands, Dordrecht.
Ismail AK. 2015. Snakebite and envenomation management in Malaysia. *Clinical Toxinology Asia Pacific and Africa* 2: 71–102.
Ismail AK, Teo EW, Das I, Vasaruchapong T & Weinstein SA. 2017. *Land Snakes of Medical Significance in Malaysia*. Ministry of Natural Resources and Environment, Putrajaya. 80 pp.
Kasturiratne A, Wickremasinghe AR, de Silva N, Gunawardena NK, Pathmeswaran A, Premaratna R, Savioli L, Lalloo DG & de Silva HJ 2008. The global burden of snakebite: a literature analysis and modelling based on regional estimates of envenoming and deaths. *PLoS Med* 5(11), e218.
Mackessy SP. (Ed.). 2016. *Handbook of Venoms and Toxins of Reptiles*. CRC press, Florida. 528 pp.
Remote Envenomation Consultation Services. 2012. http://mstoxinology.blogspot.com/p/recs.html Retrieved 8 September 2020.
Weinstein SA. 2015. Snake venoms: A brief treatise on etymology, origins of terminology, and definitions. *Toxicon* 103: 188–195.
World Health Organization. 2016. Guidelines for the clinical management of snake bite in the South East Asia region. New Delhi WHO South East Asia Regional Office.
World Health Organization. 2019. Snakebite envenoming: a strategy for prevention and control. Geneva: World Health Organization.

We welcome articles on new research information on flora or fauna and discussions related to biodiversity or conservation. Please send articles to:

The Editor,
Conservation Malaysia Bulletin,
Forest Research Institute Malaysia,
52109 Kepong, Selangor.
(attn:Ms. Ong Su Ping, ongsuping@frim.gov.my)

Conservation Malaysia is published twice a year and hardcopies are free upon request. Please contact The Editor for queries or comments. Past issues are available at: https://www.mybis.gov.my/one/publication.php?menu=27&g=1. Funded by the Ministry of Energy and Natural Resources. Editorial team: Dr. Lee Su See, Dr. Lillian Chua, Dr. Chan Yoke Mui and Ms. Ong Su Ping.