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A checklist of cephalopods from continental shelf of Sarawak, Malaysian Borneo

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Abstract. *Morni WZW, Hassan R, Abit LY, Latif K. 2022. A checklist of cephalopods from continental shelf of Sarawak, Malaysian Borneo. Biodiversitas 23: 3203-3208.* Cephalopods can be discovered in all the oceans of the world ranging from shallow to deep oceans. It is a naturally inhabited seawater medium and indirectly limits the number of research regarding the species composition of the cephalopods group. Previously, samples of cephalopods were collected from selected stations in Sarawak Exclusive Economic Zone (EEZ) using an otter trawl net with a stretch mesh size of 38 mm at the cod end. All samples used in this study were the by-catch of trawling activities during National Demersal Fish Resource Survey in Sarawak (16 August until 6 October 2015). Trawling operations were conducted beyond 12 nautical miles from the coast, and the area was divided into three depth strata, I) 20-50 m; II) 50-100 m; and III) 100-200 m. In total, 16 species of cephalopods were found to inhabit Sarawak waters, representing five families and eight genera. The present findings found that there was a higher number of species recorded in-depth strata I (14 species) in comparison to strata II (12 species) and III (11 species). Six species of the cephalopods captured in this study were the first recorded in Malaysian water, namely *Amphioctopus marginatus, Amphioctopus rex, Ommastrephes bartramii, Sepia brevimana, Sepia vietnamica* and *Sepia prashadi*. Thus, the information on cephalopod diversity and distribution at different depth strata will be useful for updating the current database on Malaysian marine species diversity.

Keywords: Cuttlefish, depth strata, first record, octopus, squid

INTRODUCTION

Cephalopods are the third-largest molluscan class after gastropods and bivalves. There are more than 800 species distributed throughout the world's oceans (Arkhipkin et al. 2015). Cuttlefish, squid and octopus are the major groups of cephalopods. The diversity of this group is presumably higher than the current records, which are surprisingly low, despite Malaysia being part of the high biodiversity region of South East Asia (Shabdin 2014). This group of mollusks consists of a large number of taxa occurring exclusively in shallow to deep water marine environments (Hildenbrand et al. 2021). Cephalopods play a significant role as a source of nutrition for humans, fish, crustaceans and even other cephalopods. In terms of economic importance, cephalopods are a significant contributor to the fisheries industry in many countries across the globe with a collective net value in the billions of dollars (Ospina-Alvarez et al. 2022). The worldwide cephalopod trade industry is a multi-billion dollar business that centers on just 10 of the most commercially important cephalopod species. Cephalopod-based fisheries have expanded in size and economic importance over recent decades, although only 4 out of the 28 known taxonomic families are of any real commercial significance (Vieites et al. 2019). Cephalopods are generally not the main target species of commercial or recreational fishing gear (with the exception of squid jigs and nets), however, the development of specific harvesting techniques could in the future provide a more consistent supply of high-quality cephalopod including currently under-exploited species of potential (Schickele et al. 2021). The shrinking of traditional marine resources and natural stock of targeted species would shortly prompt the need to diversify and seek new resources to exploit resulting in a wider range of cephalopod-based products tailored to meet market demands (Ospina-Alvarez et al. 2021). Currently, there is still a lack of regulation in large-scale fisheries operations in regard to cephalopods and little is known on the true status of cephalopod stocks in the wild (Pita et al. 2021).

The highest diversity in cephalopods occurs in the Pacific Ocean (213 cephalopod species), followed in descending order by the Indian ocean (146 cephalopod species), Atlantic (95 cephalopod species), Southern Ocean (15 cephalopod species) and finally the Arctic Ocean (12 cephalopod species) (Rosa et al. 2019). However, only 20 genera live exclusively in the tropics. Additionally, the highest number of genera is observed in the Indo-West Pacific tropical region (including the South China Sea). In the year 2000, Norman and Lu (2000) reported that about 31 families and 120 species of cephalopods were found in the South China Sea. However, in 2016, the number reported increased to 32 families and 153 species (Norman et al. 2016). This updated information is based on revisions and observation of all cephalopod studies from countries within the South China Sea: Philippines, Hong Kong, Thailand, China and Vietnam.

The Exclusive Economic Zone (EEZ) is a maritime zone (200 nautical miles) where coastal states have a sovereign right over their natural resources. Malaysia's EEZ area consists of 548,800 km^2, and Sarawak, the largest state in Malaysia, comprises 160,000 km^2 of that total area (Jamil and Hadil 2012; Mohd-Khatib 2015; Morni et al. 2017). However, limited information is available on the diversity of cephalopods in Sarawak waters. In the early 1900, the taxonomic studies on the cephalopods in Malaya (currently Peninsular Malaysia) were initially started by the British at the Malacca straits. The species that were described by the British were *O. granulatus*, *O globosus* and *O. macropus*. With the progression of time, more studies on various topics concerning cephalopods were carried out by local researchers, i.e., squid and cuttlefish' current status in Peninsular Malaysia (Abu-Talib and Mahyam 1986), gear used in squid fishery (Mohd-Jani 2015), *Sepioteuthis lessoniana* stock estimation (Samsudin 1993), population biology of cephalopods (Samsudin 2001), diversity of cephalopod from selected division in Sarawak (Rubaie et al. 2012). The diversity of species within an area is a widely acknowledged indicator of an ecosystem's health, function and resilience (Keller et al. 2016). The collective data from these scientific writings showed a total of 21 species and five families of cephalopod recorded from Malaysia. Even though cephalopods contribute around 70,000 metric tonnes of total Malaysia fisheries landings (Annual Fisheries Statistic 2019), however, a more concentrated effort is still necessary to investigate the many unexplored diversity facets of this group of animals, as the sum of published data on cephalopod diversity in Malaysia is still lacking.

In 2015, the Fisheries Research Institute (FRI), Bintawa Sarawak, Department of Fisheries (DOF) Malaysia conducted part of the National Demersal Fish Resource Survey in Sarawak, Sabah and Labuan. Therefore, an investigation of cephalopod species diversity was conducted in Sarawak waters concurrently as a side product of the main survey on finfish. This paper provides a preliminary checklist and locality information of cephalopod species distributed in the EEZ of Sarawak. The findings of the present study will be useful in updating the currently available database of information regarding Malaysian marine species diversity.

MATERIALS AND METHODS

Study area: The collection of samples was carried out at 153 trawling stations throughout the Sarawak EEZ (Figure 1). The sampling stations were randomly selected by FRI, DOF, Malaysia. The National Demersal Fish Resource Survey (16 August until 6 October 2015) was carried out using the research vessel M.V. SEAFDEC 2 owned by the Southeast Asian Fisheries Development Centre (SEAFDEC) based at the SEAFDEC Training Department, Bangkok, Thailand. Research teams from Universiti Malaysia Sarawak (UNIMAS) were invited to join the survey efforts with a focus on the biodiversity of invertebrate fauna within the selected sampling areas.

Trapped cephalopods in sampling nets were separated from finfish (main survey), sorted and measured. In addition, an otter trawl net (mesh size 38 mm at the cod end) was applied in the study and surveyed areas extended beyond 12 nautical miles from the coast of Sarawak. The surveyed areas were divided into three different depth strata, i.e., I) 20-50 m; II) 50-100 m; and III) 100-200 m (Morni et al. 2017). Trawling or dragging is a commonly used method for commercial marine fish harvesting and is relatively indiscriminate in the types of species captured through its use (Walker et al. 2017).

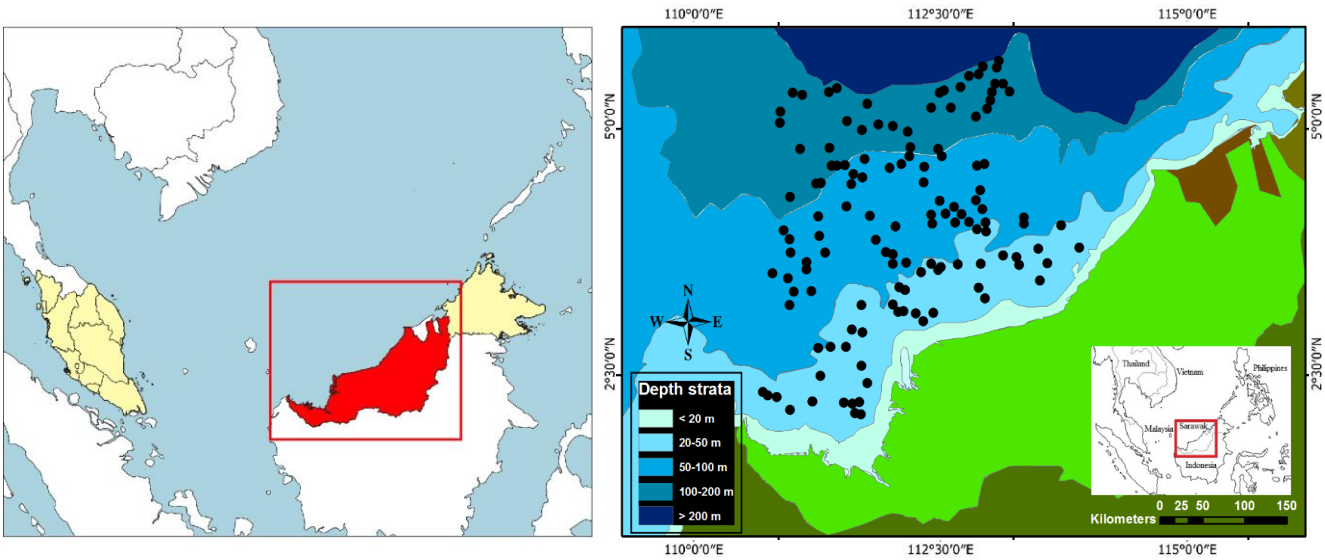

Figure 1. A total of 153 sampling stations on the continental shelf of Sarawak, Malaysia

Species identification: All samples were identified to the lowest possible taxonomic level, based on identification keys from Jereb and Roper (2010) and Jereb et al. (2016). The validity of each species was checked against the World Register of Marine Species (WoRMS) (WoRMS Editorial Board 2021). The voucher specimens were kept at minus 20°C throughout the duration of the field survey. After the completion of species identification, samples were placed in 10% formaldehyde for a period of one month, and the formaldehyde was totally replaced with 70% ethanol for long-term preservation. Selected specimens were deposited at the Aquatic Invertebrate Museum, Faculty of Resource Science and Technology, UNIMAS.

RESULTS AND DISCUSSION

Five cephalopod families, namely Loliginidae, Octopodidae, Ommastrapidae, Sepiidae and Sepiolidae (Table 1) were detected in Sarawak waters. Family Loliginidae was represented by four species, namely *Sepioteuthis lessoniana, Uroteuthis chinensis, U. duvaucelii* and *U. singhalensis*. While Family Octopodidae was represented by four species: *Amphioctopus marginatus, A. rex, Callistoctopus* sp. and *Cistopus* sp. Family Ommastrapidae and Sepiolidae were represented by one species for each family, namely *Ommastrephes bartramii* and *Euprymna morsei*, respectively. Lastly, Family Sepiidae was represented by six species: *Sepia brevimana, S. lycidas, S. pharaonis, S. prashadi, S. recurvirostra* and *S. vietnamica*.

Previously, in the Family Loliginidae, *U. chinensis, U. duvaucelii* and *U. singhalensis* were classified under the genus *Loligo*, as *L. chinensis, L. duvaucelii* and *L. singhalensis*. Natsukari (1984) subdivided the genus *Loligo* and established Photololigo. Due to the presence of two photophores on the ventral side of their ink sacs, *L. chinensis, L. duvaucelii* and *L. singhalensis* were recombined as *Photololigo chinensis, P. duvaucelii* and *P. singhalensis* by Natsukari (1984) to denote this feature. However, two squid taxa share similar generic characters as *Uroteuthis*. Therefore, *Uroteuthis* is used as the genus name (Norman et al. 2016), as opposed to Photololigo, which is considered a valid subgenus of *Uroteuthis*.

Two species in Family Loliginidae, *U. chinensis* and *U. duvaucelii*, were found to inhabit all depth strata of the present study. *Uroteuthis chinensis* was the most commonly prevalent species found in the Family Loliginidae, and it was distributed in 64 from 153 stations. This was followed by *U. duvaucelii* (20 stations), *S. lessoniana* (2 stations) and *U. singhalensis* (1 station). The results found in the current survey were similar to an earlier study by Samsudin (2001) in his 1998 survey of Sarawak waters, where he discovered that both *U. chinensis* and *U. duvaucelii* were well distributed at various depth strata. The mitre squid *U. chinensis* can be found at a wide depth range of 15 to 170 m (Islam et al. 2018), which was supported by the findings of the present study. These species are one of the high economic contributors and importance throughout the Indo-Pacific region (Van Anrooy et al. 2022). They are caught in large numbers either as a targeted species or as by-catch products from the commercial fishery industries (Carpenter and Niem 1998). Interestingly, the bigfin squid *S. lessoniana* was previously reported to inhabit subtidal areas to a depth of 45 m (Alexander et al. 2015) and 100 m (Chiang et al. 2020) while in contrast, during the present study, this species was found at two stations in the Sarawak EEZ at a depth of 20 m and 140 m, respectively.

Table 1. Distribution of cephalopods according to species and depth strata in the continental shelf of Sarawak, Malaysian Borneo (2015)

Order	Species	Depth (Meters)		
		Strata I 20-50	**Strata II 50-100**	**Strata III 100-200**
Myopsida	*Uroteuthis (Photololigo) chinensis*	+	+	+
	Uroteuthis (Photololigo) duvaucelii	+	+	+
	Uroteuthis (Photololigo) singhalensis	+	-	-
	Sepioteuthis lessoniana	+	+	-
Octopoda	*Amphioctopus marginatus*	+	+	+
	Amphioctopus rex	+	+	+
	Cistopus sp.	-	-	+
	Callistoctopus sp.	-	+	+
Oegopsida	*Ommastrephes bartramii*	+	+	+
Sepiida	*Sepia brevimana*	+	+	+
	Sepia lycidas	+	+	-
	Sepia pharaonis	+	+	+
	Sepia prashadi	+	-	-
	Sepia recurvirostra	+	+	+
	Sepia vietnamica	+	+	+
	Euprymna morsei	+	-	-

Table 2. Comparison of cephalopod species recorded from a previous survey in 1998 (Samsudin 2001) to the present study 2015. The IUCN status was provided with year of the species were last assessed in the IUCN Red List of Threatened Species (DD-Data deficient, LC- Least concern, NA- Not available)

Family	Species	IUCN Status (last assessed)	Survey	
			1998	2015
Loliginidae	* *Loligo chinensis* [*Uroteuthis (Photololigo) chinensis*]	DD (2015)	+	+
	* *Loligo duvaucelii* [*Uroteuthis (Photololigo) duvaucelii*]	DD (2015)	+	+
	* *Loligo singhalensis* [*Uroteuthis(Photololigo)singhalensis*]	DD (2015)	+	+
	**Loligo tago* [*Loliolus uyii*]	DD (2015)	+	-
	**Loligo sibogae* [*Uroteuthis sibogae*]	DD (2015)	+	-
	Sepioteuthis lessoniana	DD (2014)	+	+
Octopopidae	*Amphioctopus marginatus*	LC (2014)	-	+
	Amphioctopus rex	LC (2014)	-	+
	Callistoctopus sp.	NA	-	+
	Cistopus sp.	NA	-	+
	Octopus cyanea	LC (2014)	+	-
Ommastrepidae	*Ommastrephes bartramii*	LC (2010)	-	+
	**Nototodarus philippinensis* [*Nototodarus hawaiiensis*]	LC (2010)	+	-
	Todarodes pacificus	LC (2010)	+	-
Sepiidae	*Sepia aculeata*	DD (2009)	+	-
	Sepia brevimana	DD (2009)	-	+
	**Sepia inermis* [*Sepiella inermis*]	DD (2009)	+	-
	Sepia latimanus	DD (2009)	+	-
	Sepia lycidas	DD (2009)	+	+
	Sepia pharaonis	DD (2009)	+	+
	Sepia prashadi	LC (2009)	-	+
	Sepia recurvirostra	DD (2009)	+	+
	Sepia vietnamica	DD (2009)	-	+
Sepiolidae	*Euprymna morsei*	DD (2009)	+	+

Note: *Updated scientific names are in brackets "[ ]" names are based on listings of the World Register of Marine Species (WoRMS Editorial Board 2021)

The most commonly distributed species from Family Octopodidae was *A. marginatus* which was found at 19 out of the 153 stations sampled, this was followed by *A. rex* (4 stations), *Cistopus* sp. (3 stations) and *Callistoctopus* sp. (3 stations). Two of the species, namely, *A. marginatus* and *A. rex* were the first record of these particular species found within the boundaries of Malaysian maritime waters. The veined octopus, *A. marginatus*, inhabits a wide depth range from shallow subtidal zones to depths of 190 m and is widely distributed in tropical continental waters from the Indian Ocean to north-eastern Australia (Jereb et al. 2016). This particular species is one of the species of octopods that was reported to have bipedal locomotion movement behavior (Sreeja and Bijukumar 2013; Amodio et al. 2021). An interesting finding from this study was that the king ocellate octopus, *A. rex* was found to inhabit all the sampled depth strata of the study (from 25-136 m). This finding was in contrast to an earlier study by Jereb et al. (2016), who reported that *A. rex* was only found at a depth of 80 m. This species can be identified by the iridescent violet ring present in the dark ocellus on the web between the bases of arms II and III (Tang et al. 2020)

The neon flying squid, *O. bartramii* from Family Ommastrapidae, was found at all depth strata with distribution in 17 out of the 153 stations sampled. This species is also the first record from Malaysian waters. *Ommastrephes bartramii* has a wide distribution in subtropical oceans and inhabits all water columns from 0-1500 m depths (Jereb and Roper 2010). Interestingly during a 1998 study, two oceanic squids belonging to the same family (Ommastrapidae) as *O. bartramii* were found in Sarawak waters, namely, *Nototodarus philippinensis* and *Todarodes pacificus* (Samsudin 2001), however, no samples of both of these species were found during the present study. The Mimika bobtail squid, *E. morsei*, from the Family Sepiolidae, was found at two stations in strata II. This species is newly added in the cephalopod distribution pattern by Norman et al. (2016), which was not previously reported during their initial study by Norman and Lu (2000). *Euprymna morsei* is a species that was anticipated to be found in the South China Sea. Still, no published record of its presence was currently available, except for areas in Southern Japan (Ikeda 2021), until the present study.

Three species from Family Sepiidae, *S. brevimana*, *S. recurvirostra* and *S. vietnamica* were found to inhabit all depth strata of the study. *Sepia recurvirostra* was the most common species found, with a wide distribution at 43 out of 153 stations sampled. This was followed by *S. brevimana* (36 stations), *S. vietnamica* (23 stations), *S. pharaonis* (11 stations), *S. lycidas* (4 stations) and *S. prashadi* (1 station) (Figure 5). Three species of cuttlefish from the present study were also the first record of their presence in Malaysian waters, namely, *S. brevimana*, *S. prashadi* and *S. vietnamica*. Five of the cuttlefish species recorded during this study, with the exclusion of *S. vietnamica*, were reportedly present in Thailand waters (Nateewathana 2008; Tuanapaya and Nabhitabhata 2017). Basically, cuttlefish are bottom-dwellers and slower swimmers than animals in the squid group (Reid et al.

2005). This is a possible reason to explain the high number of species recorded from this group during the present study. Besides, the gear used in this study (otter trawl net-bottom trawl) may have influenced the prevalence of species caught. According to Jereb and Roper (2005), *S. brevimana* and *S. vietnamica* were found to inhabit depths of 10-100 m and 24-104 m, respectively. In contrast, in the present study, *S. brevimana* and *S. vietnamica* were found inhabiting depths of 35-189 m and 25-189 m depth, respectively, suggesting that their depth range was considerably higher than previously thought.

In total, 24 species of cephalopods were recorded in Sarawak waters, based on the compilation of data from both the earlier 1998 and the most recent 2015 survey. The composition of cephalopods consisted of ten, nine and five species of squids, cuttlefishes and octopods, respectively (Table 2). Four species of cephalopods collected during this study, *A. marginatus*, *A. rex*, *O. bartramii* and *S. prashadi*, were both classified as a 'least concern' under the International Union for Conservation of Nature (IUCN) Redlist of threatened species (2021).

In conclusion, the present study recorded 16 species of cephalopods representing five families and eight genera inhabiting different areas within the Sarawak EEZ. From the total number of recorded species, there were 14 species found in strata I (20-50 m), 12 species in strata II (50-100 m) and 11 species in strata III (100-200 m). A total of six species of cephalopods mentioned in this study were the first record of their presence in Malaysian waters, these six species are: *A. marginatus*, *A. rex*, *O. bartramii*, *S. brevimana*, *S. vietnamica* and *S. prashadi*. However, due to the scope of this study (whereby cephalopods were the by-catch of the main finfish survey being carried out), the real numbers of cephalopod species inhabiting the Sarawak EEZ may, in actuality, be much higher than currently thought. Future studies specifically focusing on cephalopods with suitable capture gear would be required to obtain a more complete picture of the true diversity of cephalopods inhabiting the Sarawak EEZ. However, the present study is a valuable contribution of new baseline information, which will contribute towards a better understanding of cephalopod diversity and distribution in Malaysian waters.

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