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The Abundance and Distribution of Mangrove Gastropods from Kuala Selangor Nature Park, Selangor

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ABSTRACT

This study reports on the abundance and distribution of mangrove gastropods from Kuala Selangor Nature Park, Malaysia (KSNP). The line transect method with quadrats (5m x 5m) was employed to sample the gastropods. Gastropods were collected from the leaves, branches, stems and roots of trees and the mangrove floor. Nineteen gastropod taxa from seven families were recorded from the *Bruguiera*, mixed (*Bruguiera*, *Avicennia* and *Rhizophora*), *Avicennia* and *Rhizophora* zones. *Avicennia* sp. recorded the largest Girth at Breast Height (GBH) (mean±sd=37.3±18.2 cm) while *Bruguiera* sp. recorded the smallest GBH (mean=22.36±8 cm). The overall density of the gastropods at KSNP was 0.85 no/m^2. The gastropod density was higher at the *Avicennia* & *Rhizophora* zone (150-200m (closer to the mudflats) (0.064±0.084 no/m^2) followed by the mixed zone (50-150m) (0.046±0.30 no/m2) and lowest at the *Bruguiera* zone (0-50m) (0.08±0.080 no/m^2) (closer to the coastal bund). Gastropod density between sampling zones did not vary significantly ($p>0.05$) but generally increased from the bund towards the mudflat edge. Further studies of the role of gastropods in the coastal food chain, as bio-indicators of habitat change and as potential food source for local populace are needed.

Keywords: *Abundance, gastropods, mangrove and Kuala Selangor Nature Park*

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INTRODUCTION

Gastropods are a highly differentiated class in the Mollusca phylum and covers almost 80% of the taxa in the phylum. Some of these gastropods are terrestrial while others live in freshwater and marine habitats. There are about 85,000 – 100,000 known species of molluscs [1]. Gastropods are essential and significant components of the mangrove food web [2]. They are primary consumers in the trophic levels of the mangrove ecosystem, either as grazers or as suspension feeders. There is paucity on the literature related to gastropods with respect to their abundance in Malaysian mangroves [2-7]. Gastropods have ecological roles in the mangrove food web and such roles are poorly understood [8-11].

Notwithstanding Kuala Selangor Nature Park's establishment in 1987, studies on its mangrove ecology is scanty, especially those related to gastropods. The nature park has received little attention on studies related to gastropods among local researchers perhaps due to their low economic value. There is also no reliable temporal data on the populations of the mangrove gastropods which are important as these organism act as bio-indicators of change and disturbance as well as the state of health of the environment in which they live in [11,12]. This paper reports on the abundance of the gastropods of Kuala Selangor Nature Park.

METHODOLOGY

Sampling Location

The study site is a well-managed mangrove ecosystem located at Kuala Selangor Nature Park, Kuala Selangor, Malaysia (3.3390° N, 101.2448° E) (Figure 1). This environmentally sensitive area of Kuala Selangor was gazetted as a public park in 1987 [4]. The main mangrove tree genera that are found include *Avicennia, Rhizophora* and *Bruguiera*.

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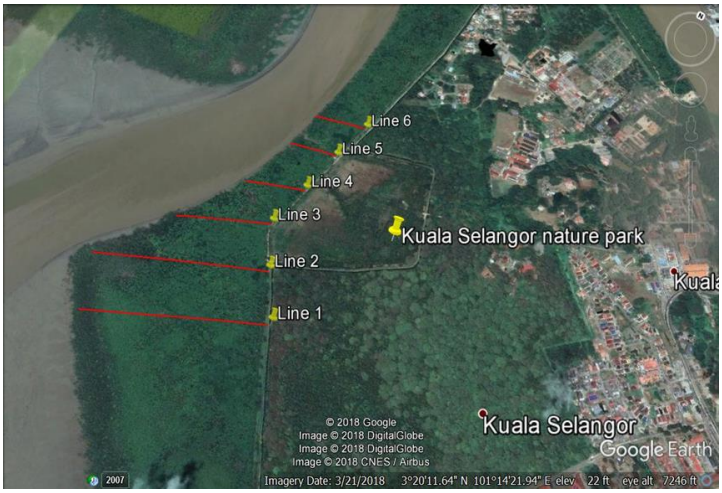

Figure 1: Map of Kuala Selangor Nature Park showing study sites (Google Earth, 2018) (Line refers to transect lines)

Sampling Method

Gastropod sampling was conducted utilizing the line transect and quadrat method. The sampling area was subjected to representative transect lines with at least five quadrats of dimensions 5m x 5 m placed between 10 – 20 m apart starting from the coastal bund to the edge of the mudflats (Figure 2). The distance between each transect line was approximately 200 m. The GPS coordinates of the quadrats are listed in Table 1. The Girth at Breast Height (GBH) of the mangrove trees within each quadrat was determined at 1.3 m above ground. For mangrove trees like *Rhizophora* sp., which has a complex root structure, the GBH was recorded (1.5 m) above the highest prop root [13,14]. Gastropods were collected by hand from the mangrove floor, roots, stem, branches and leaves within each quadrat. The sampled gastropods were then put into labelled plastic bags (transect line, quadrat, date) and were brought back to the laboratory for identification and enumeration.

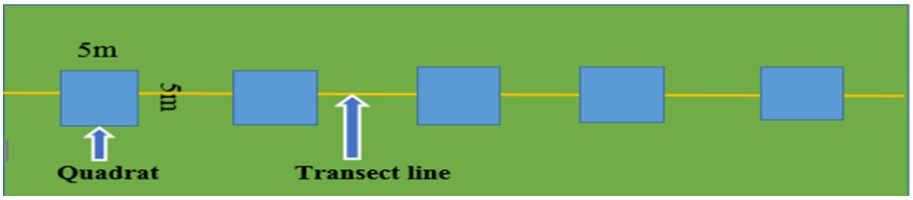

Figure 2: Illustration of the Transect Line with Quadrat Sampling Method

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Table 1: Coordinates of Transect Lines and their Quadrats at Kuala Selangor Nature Park

Transect	Coordinate	Transect	Coordinate	Transect	Coordinate
T1Q1	3°20'02.74"N 101°14'19.43"E	T2Q1	3°20'05.08"N 101°14'08.80"E	T3Q1	3°20'09.22"N 101°14'09.96"E
T1Q2	3°20'02.72"N 101°14'11.56"E	T2Q2	3°20'05.06"N 101°14'09.66"E	T3Q2	3°20'09.28"N 101°14'08.76"E
T1Q3	3°20'02.88"N 101°14'09.98"E	T2Q3	3°20'05.21"N 101°14'07.37"E	T3Q3	3°20'09.07"N 101°14'07.85"E
T1Q4	3°20'02.96"N 101°14'08.60"E	T2Q4	3°20'05.42"N 101°14'06.55"E	T3Q4	3°20'09.45"N 101°14'06.76"E
T1Q5	3°19'57.80"N 101°14'12.92"E	T2Q5	3°20'05.13"N 101°14'05.60"E	T3Q5	3°20'09.45"N 101°14'05.94"E
T1Q6	3°20'06.75"N 101°14'17.04"E	T2Q6	3°20'03.72"N 101°14'05.66"E	T3Q6	3°20'09.89"N 101°14'04.68"E
T1Q7	3°20'08.58"N 101°14'25.96"E	T2Q7	3°20'05.54"N 101°14'03.54"E	T3Q7	3°20'10.09"N 101°14'03.67"E
T1Q8	3°20'03.07"N 101°14'25.96"E	T2Q8	3°20'05.53"N 101°14'02.61"E	T3Q8	3°20'10.11"N 101°14'02.87"E
T1Q9	3°20'03.02"N 101°14'01.77"E	T2Q9	3°20'05.83"N 101°14'01.01"E	T3Q9	3°20'10.20"N 101°14'02.25"E
T1Q10	3°20'02.98"N 101°14'00.21"E	T2Q10	3°20'06.05"N 101°13'59.76"E	T3Q10	3°20'10.58"N 101°14'01.46"E
Transect	Coordinate	Transect	Coordinate	Transect	Coordinate
T4Q1	3°20'`12.89"N 101°14'11.04"E	T5Q1	3°20'18.05"N 101°14'11.84"E	T6Q1	3°20'25.45"N 101°14'13.89"E
T4Q2	3°20'`13.07"N 101°14'09.81"E	T5Q2	3°20'18.07"N 101°14'10.49"E	T6Q2	3°20'25.88"N 101°14'12.42"E
T4Q3	3°20'`13.01"N 101°14'08.51"E	T5Q3	3°20'07.19"N 101°14'17.01"E	T6Q3	3°20'25.37"N 101°14'10.87"E
T4Q4	3°20'`13.66"N 101°14'06.22"E	T5Q4	3°20'18.13"N 101°14'08.98"E	T6Q4	3°20'25.58"N 101°14'09.58"E
T4Q5	3°20'`13.65"N 101°14'04.45"E	T5Q5	3°20'18.22"N 101°14'07.80"E	T6Q5	3°20'26.75"N 101°14'08.24"E

Gastropod and Mangrove Trees Identification

Gastropods was identified utilizing taxonomic keys in [2,6,7,15-17]. Mangroves were identified utilizing taxonomic keys in [18,19].

Gastropods Density

Gastropod population density (D) was determined via the following formula: D = N/A. Where; D =density (no/m^2); N = number of individuals; A = area of sampled plots.

Statistical Analysis

ANOVA (Analysis of Variance) was utilized to test for significant difference between gastropod densities with respect to horizontal distribution (mangrove tree zones). SPSS version 21.0 (IBM Corp, 2012) was utilized to run the ANOVA.

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RESULTS AND DISCUSSION

Mangrove Tree Taxa

Among the mangroves, *Avicennia* sp., *Bruguiera* sp. and *Rhizophora* sp. were recorded within the sampling quadrats at Kuala Selangor Nature Park. Asmawi *et al*. [20] also noted *Avicennia* sp., *Bruguiera* sp. and *Rhizophora* sp. in the mangroves at Kuala Selangor Nature Park (Table 2 and Figure 3). *Avicennia* sp. recorded larger (GBH) (mean=37.3±18.2 cm) while *Bruguiera* sp. recorded smaller GBH (mean = 22.36 ± 8 cm). *Avicennia* sp. *a*nd *Rhizophora* sp. density increased from the coastal bund towards the mudflat edge (50 m – 200 m from the coastal bund). *Bruguiera* sp. density decreased from the landward side towards the mudflat edge but was highest from the coastal bund until 50 m (Figure 3).

Table 2: Mangrove Tree Density in Sampling Quadrats from Kuala Selangor

Mangrove Taxa	***Bruguiera* zone (0-50 m)**	**Mixed zone (50-150 m)**	***Avicennia* & *Rhizophora* zone (150-200 m)**	**Mean GBH (cm)**
	no/ha	no/ha	no/ha	
Avicennia sp.	333	810	3333	37.3 ± 18.2
Bruguiera sp.	4167	2546	1167	22.3 ± 8.6
Rhizophora sp.	250	1273	4000	35.1 ± 13.4

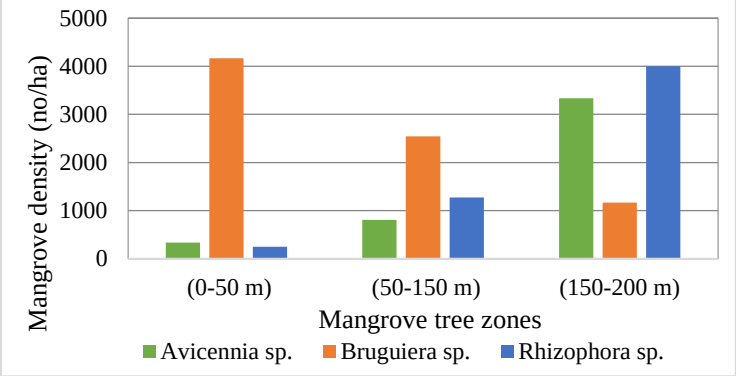

Figure 3: Mangrove tree taxa density in sampling quadrats at Kuala Selangor Nature Park

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Gastropod Community Composition and Density

Seven families comprising 19 gastropod taxa were recorded from the sampling quadrats at Kuala Selangor Nature Park (Table 3). The gastropods were represented by the Potamididae (*Cerithidea obtusa, Cerithidea cingulata, Telescopium telescopim,* and *Telescopium mauritsi*), Ellobiidae (*Ellobium aurisjudae, Cassidula aurisfelis, Cassidula nucleus and Phytia plicata*), Littorinidae (*Littoraria scabra, Littoraria conica, Littoraria undulata and Littoraria melanostoma*) comprising four taxa each; the Naticidae by three taxa (*Nerita balteata, Neritina cornucopia and Nerita violacea*) and a single taxa each for Assiminidae (*Sphaerassiminea miniata),* Muricidae (*Chicoreus capucinus*) and Haminoeidae (*Haminoea* sp.). The Potamididae was the most abundant among the gastropod community (38%) followed by Ellobidae (20%), Littorinidae (10%), Naticidae (16%), Assiminidae (11%), Muricidae (4%) and Haminoeidae (0.3%) (Table 3).

Table 3: Gastropod taxa abundance recorded from the mangroves of Kuala Selangor Nature Park

Gastropod Family	Gastropod Taxa	n	Abundance (%)
Assimineidae	*Sphaerassiminea miniata*	109	10.9
Ellobiidae	*Ellobium aurisjudae*	43	4.3
	Phythia plicata	2	0.2
	Cassidula aurisfelis	65	6.5
	Cassidula nucleus	87	8.7
Haminoeidae	*Haminoea* sp.	3	0.3
Littorinidae	*Littoraria conica*	45	4.5
	Littoraria scabra	43	4.3
	Littoraria melanostoma	8	0.8
	Littoraria undulata	4	0.4
Muricidae	*Chicoreus capucinus*	42	4.2
	Indothais rufotinacta	2	0.2
Naticidae	*Nerita balteata*	150	15

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	Neritina cornucopia	5	0.5
	Nerita violocea	4	0.4
Potamididae	*Cerithidea cingulata*	67	6.7
	Cerithidea obtusa	182	18.2
	Telescopium telescopium	113	11.3
	Telescopium mauritsi	22	2.2

The overall density of the gastropods at KSNP was 0.85 no/m^2. The density of the gastropods generally increased from the coastal bund towards the mudflats edge (Table 5). The gastropod density was higher at the *Avicennia* & *Rhizophora* zone (0.064±0.084 no/m^2) (150-200 m from coastal bund) followed by the mixed zone (50-150 m from coastal bund) (0.046±0.30 no/m^2) and lowest at the *Bruguiera* zone (0-50 m from the coastal bund) (0.08 ± 0.080 no/m^2) (Table 4). The gastropod density between the mangrove zones was not significantly different ($p>0.05$). The higher density of *S. miniata* recorded from the mixed zone (50-150 m from coastal bund) was probably related to larger microhabitat availability and better food quality. The gastropod density at KSNP was lower as compared to other mangroves in Selangor [17].

Table 4: Gastropod density by sampling zones at Kuala Selangor Nature Park

Mangrove zones	Distance from Coastal Bund (m)	n	Mean ± SD	Std. Error
Bruguiera zone	0-50	8	0.08 ± 0.08	0.028
Mixed zone	50-150	11	0.046 ± 0.03	0.009
Avicennia & *Rhizhopora* zone	150-200	16	0.064 ± 0.08	0.021

Wong & Arshad [21] listed 388 gastropod taxa in Malaysia but stated that there is paucity on the total diversity and species richness of the marine shelled molluscs in Malaysia. The current study recorded the Littorinidae, Neritidae, Potamididae, Cerithidae, Ellobiidae, Muricidae and Assimineidae. The Littorinidae, Neritidae, Potamididae and Ellobiidae are common gastropod

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families of tropical mangroves [6,22]. The larger presence of the Potamididae and the Ellobiidae generally indicates older mangroves [23] such as with the KSNP mangroves. The Potamididae has wide geographical range, high abundance [5,20] and are unique to the mangrove ecosystem [24-26]. The gastropod families such as the Littorinidae, Potamididae, and Ellobiidae are more distributed and higher in abundance than other families in the mangroves of the Indo-Pacific [5,23,26]. The Littorinidae is diverse in the Southern Asian and Indo Pacific areas and abundant in mangroves that are closer to the seaward edge [27]. The widely distributed *C. obtusa* is present along the coasts in the tropical Indo-Pacific [25] and it is adapted to compete for space and food within the mangroves. Gastropods are sound bio-indicators and can warn of ecosystem degradation [28]. Nutrients, sediment texture and hydrography are probable factors responsible for the benthic macrofaunal assemblages [5]. Such indicators may be beneficial to define coastline alterations due to effects of sea level rise and anthropogenic stresses [23]. Diop [14] noted mangrove susceptibility to natural and anthropogenic pressures which allows them to be resilient to such pressures.

Table 5: Density of gastropod taxa based on horizontal zones at Kuala Selangor Nature Park

Gastropods Taxa	***Bruguiera* zone**		**Mixed zone**		***Avicennia* & *Rhizophora* zone**		**Overall Mean Density**
	0-50 m		**50-150 m**		**150-200 m**		
	Density (no/m^2)		**Density (no/m^2)**		**Density (no/m^2)**		
	n	**Mean ± SD**	**n**	**Mean ± SD**	**n**	**Mean ± SD**	
Cassidula aurisfelis	16	0.02± 0.03	36	0.04±0.004	13	0.02±0.004	0.03±0.04
Cassidula nucleus	-	-	36	0.04±0.004	51	0.1±0.09	0.04±0.07
Cerithidea cingulata	31	0.05±0.05	36	0.04±0.006	-	0.034±0.05	0.03±0.00
Cerithidea obtusa	71	0.18±0.05	76	0.08±0.043	35	0.07±0.05	0.09±0.05
Chichoreus capucinus	3	0.05±0.05	27	0.03±0.002	12	0.02±0.02	0.02±0.02
Ellobium aurisjudae	8	0.01±0.01	27	0.03±0.001	8	0.01±0.01	0.03±0.04
Littoraria conica	-	-	-	-	45	0.1±0.05	0.03±0.04
Littoraria scabra	-	-	-	-	43	0.09±0.04	0.02±0.01
Littoraria undulata	-	-	2	0.04±0.06	2	0.04±0.06	0.08±0.06
Nerita balteata	61	0.01±0.04	62	0.06±0.04	27	0.06±0.04	0.07±0.06
Sphaerassiminea miniata	-	-	65	0.1±0.016	44	0.09±0.001	0.06±0.01
Telescopium mauritsi	-	-	7	0.06±0.01	15	0.03±0.002	0.08±0.02
Telescopium telescopium	50	0.08±0.05	60	0.06±0.02	3	0.06±0.09	0.05±0.05

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Neritina cornucopia	-	-	-	-	5	0.34±0.46	0.01±0.05
Nerita violacea	-	-	-	-	4	0.01±0.003	0.04±0.07
Haminoea sp.	-	-	-	-	3	0.06±0.003	0.001±0.03
Littoraria melanostoma	-	-	3	0.03±0.01	5	0.01±0.008	0.01±0.06

CONCLUSION

The mangrove tree density decreased from the coastal bund towards the edge of the mudflats at Kuala Selangor Nature Park. This trend was also reflected in the gastropod density which decreased within the mangroves near the coastal bund towards the mudflats. Differences in densities of the gastropod species within the mangrove zones reflects their local habitat adaptation and requirements. The gastropod species richness is similar to other mangrove habitats on the west coast of Peninsular Malaysia. The role of the gastropods in the coastal food chain, their function within the mangroves, their role as bio-indicators of habitat changes and health, and their potential as food source requires further studies.

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CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare absence of conflicting interests with the funders.

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