

# Species composition and zonal distribution of mangrove plants in the Myeik coastal areas of Myanmar

## Abstract

The species composition and zonal distribution of mangroves in five research sites *viz.*, Kapa, Masanpa, Panadoug, Kywe Ka Yan and Kyauk Phyar from Myeik coastal areas were studied from December 2017 to July 2018. Transect lines in landward, seaward and shoreline, and plots based on Point Center Quarter Method (PCQM) were used. A total of 21 species of true mangrove were recorded. *Rhizophora apiculata* and *R. mucronata* were the most dominant species in the study sites, especially in the seaward areas. Among the recorded species, *Aegiceras corniculatum*, *Avicennia officinalis*, *R. apiculata*, *R. mucronata*, *Sonneratia alba* and *Nypa fruticans* were distributed in all study sites. *Bruguiera gymnorhiza* and *B.cylindrica*, were recorded only in shoreline areas and *Heritiera littoralis* was found only in landward areas in all study sites. Among the study sites, Kapa has been designated as the highest species composition, representing 17 species, whereas Kyauk Phyar, representing 12 species as the lowest species composition. The environmental parameters of mangrove forests were also provided in all study sites. The various salinity and temperature ranges of seawater (25.0-30.0‰ and 28.0-32.0°C) and soil (25.0-33.0‰ and 27.6-31.4°C) significantly controlled the distribution of mangrove species of mangroves.

**Keywords:** environmental parameters, mangrove forests, landward, seaward, shoreline, Myeik coastal areas, species composition, zonal distribution

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## Introduction

Mangroves are salt tolerant angiosperm plants, which are commonly present along the banks of coastal water bodies such as estuaries and creeks. The mangroves have adapted themselves best in the shallow seacoast, sheltered estuaries and deltaic zones of the tropics and subtropics with characteristic environmental conditions, *viz.*, ranging temperature between 20°C to 30°C, moderate to high monsoon precipitation i.e., 1000-3000 mm/annum, and high humidity but with coastal aridity. The human thrust or pressure, other biotic factors and interactions also cause changes in mangrove ecosystems. Due to this, the mangroves are now very dynamic but have become fragile throughout the world.<sup>1</sup>

Mangrove forest distributed throughout the coast of South Andaman Island, varies from small patches to dense forest.<sup>2</sup> Mangrove forests are among the world's most productive ecosystems. Mangroves and mangrove ecosystems have been studied extensively but remain poorly understood. With degradation and destruction of mangroves, there is a critical need to understand them better.<sup>3</sup>

Myanmar possesses a long coastline, including three coastal regions like Rakhine, Ayeyarwady Delta, Gulf of Martaban and Taninthayi. There are estuaries, delta systems, numerous offshore islands and a considerable diversity of coastal habitats including coral reefs, mangroves, sandy beaches and mudflats in the coastal regions.<sup>4</sup> Among the three coastal regions, Myeik zone in Taninthayi coast is

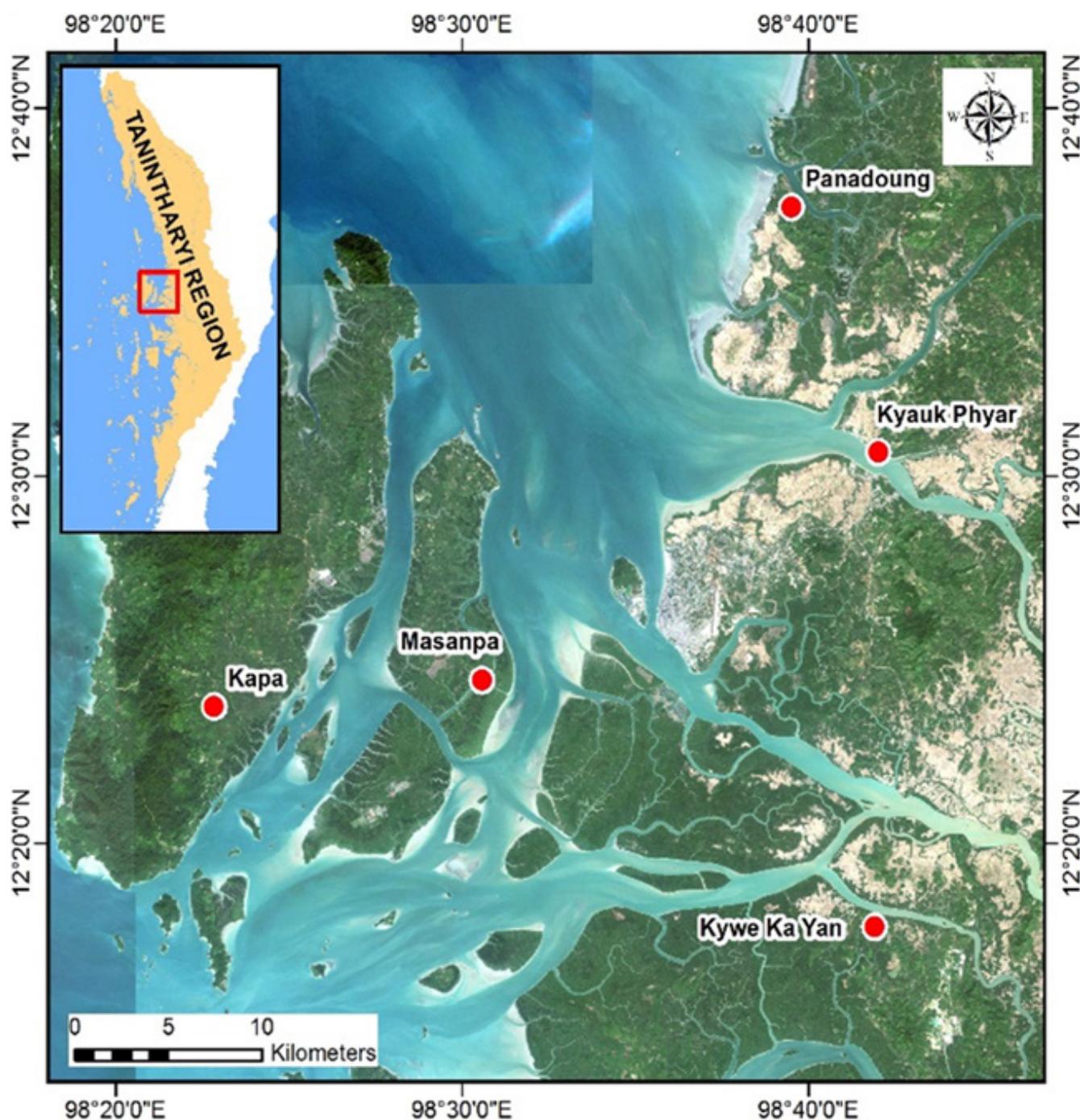
the longest coastline of about 1200km in length and has the richest diversity of coastal habitats and constitutes over 800 islands.<sup>5</sup>

Zockler and Aung<sup>6</sup> described 44 species of true mangroves in Myanmar. San Tha Tun et al.,<sup>7,8</sup> recorded 44 species of mangroves from Lampi Island and 50 species from Myeik coastal areas, respectively. Moreover, Pyae Sone Aung<sup>9</sup> described 30 species including true mangroves and its associates, and Tin-Zar-Ni-Win et al.,<sup>10</sup> recorded a total of 21 species of true mangroves in Myeik coastal areas.

The pristine mangroves and huge mudflat areas potentially host important bird diversity, and serve as roosting and feeding area for migratory water birds.<sup>11,12</sup> The areas of mangrove forests in Myanmar have been reduced with the rate of 0.70% loss per year in this century, which is substantially above the global average due to rice cultivation.<sup>13</sup> Likewise, mangroves of Myeik coastal zone dominated along the deltaic areas of the Taninthayi river are gradually degrading due to extraction of charcoal, pole, post, firewood and fuel wood.<sup>14</sup> The objective of this study was to know the composition and zonal distribution of mangrove species in Myeik coastal areas.

## Materials and methods

The present study was conducted in five villages (such as Kapa, Masanpa, Panadoug, Kywe Ka Yan and Kyauk Phyar) belonging to the mangrove forests of Myeik coastal areas (Figure 1) from December 2017 to July 2018.



**Figure 1** Study sites (red circles) in the coastal areas of Myeik.

### Data collections

A total of three transect lines along with 15 plots were laid in each study site. Therefore, a total of 15 transect lines along with 75 plots were laid in study areas such as Kapa, Masanpa, Kywe Ka Yan, Kyauk Phyar and Panadoung (Figure 2). This study followed the Point Center Quarter Method (PCQM) on the forest conditions (i.e., shoreline, seaward and landward areas), used by Dahdouh-Guebas and Koedam<sup>15</sup>

and Cintron and Novelli.<sup>16</sup> The directions of transects were laid parallel with the coast at shoreline and landward, perpendicular from the coast to the inland at seaward areas. Species recorded according to those transects, which were assumed as the zonation pattern of mangrove species trend. The lengths of the transect lines were recorded using measuring tape. The coordinate of each transect line was recorded using GPS (Table 1). The zonal distribution of species was recorded in each transect.

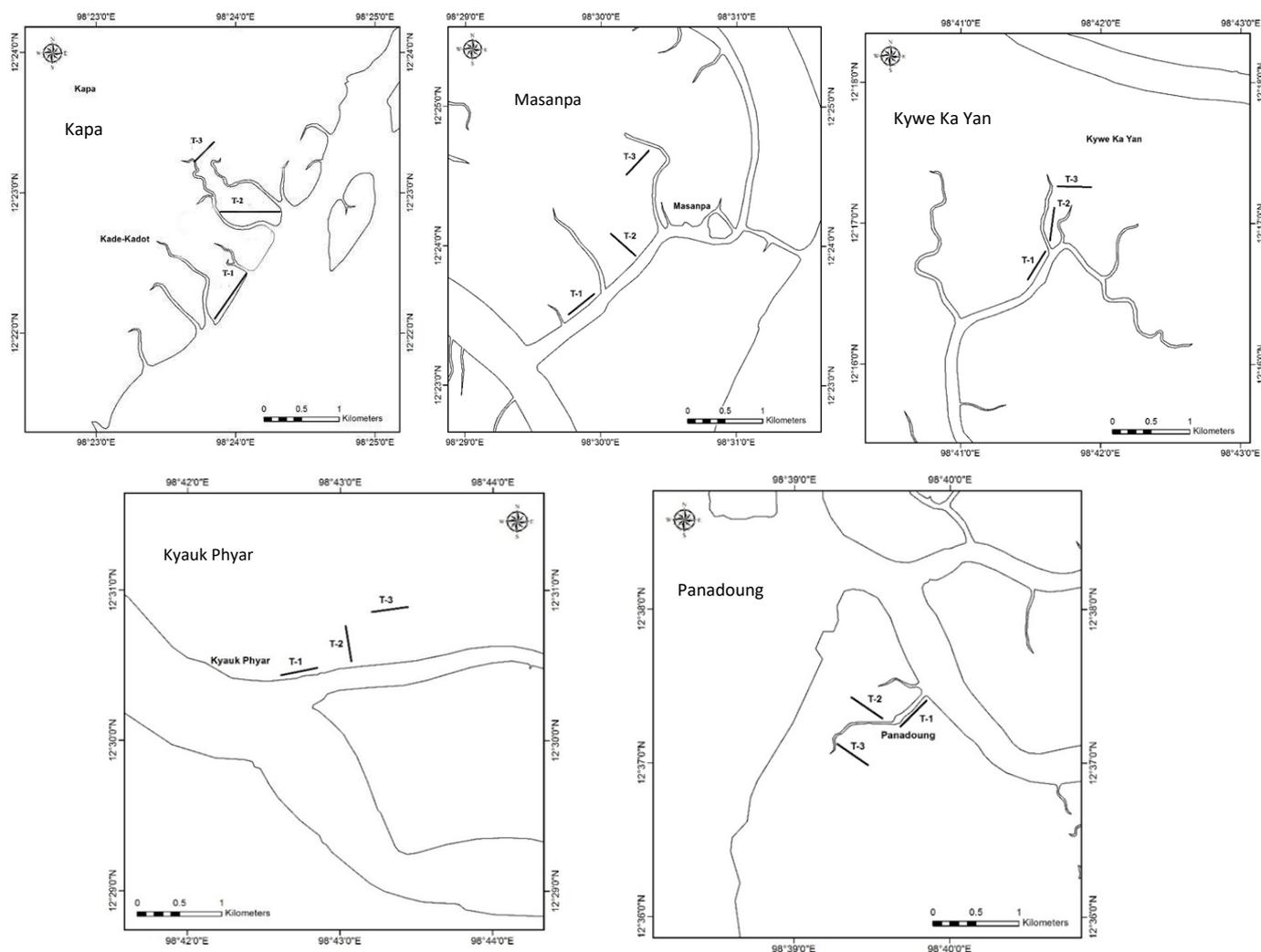


Figure 2 Map showing the transect lines at each station.

Table 1 The location and distance of transect and plot intervals of each transect line in the study sites

Sr. No.	Study sites	Transect	Position		Distance (m)	Plot interval (m)
			Latitude	Longitude		
1.	Kapa	T-1	12° 37 ' 06 " N	98° 38 ' 62 " E	450	30
		T-2	12° 37 ' 06 " N	98° 38 ' 62 " E	825	55
		T-3	12° 38 ' 56 " N	98° 39 ' 52 " E	375	25
2.	Masanpa	T-1	12° 40 ' 12 " N	98° 50 ' 14 " E	450	30
		T-2	12° 40 ' 11 " N	98° 50 ' 15 " E	450	30
		T-3	12° 40 ' 06 " N	98° 52 ' 07 " E	450	30
3.	Kywe Ka Yan	T-1	12° 15 ' 15 " N	98° 41 ' 23 " E	450	30
		T-2	12° 16 ' 29 " N	98° 41 ' 08 " E	450	30
		T-3	12° 17 ' 08 " N	98° 42 ' 04 " E	450	30
4.	Kyauk Phyar	T-1	12° 30 ' 98 " N	98° 42 ' 07 " E	450	30
		T-2	12° 31 ' 58 " N	98° 41 ' 87 " E	450	30
		T-3	12° 31 ' 37 " N	98° 42 ' 56 " E	450	30
5.	Panadoug	T-1	12° 36 ' 01 " N	98° 35 ' 33 " E	450	30
		T-2	12° 38 ' 44 " N	98° 39 ' 49 " E	450	30
		T-3	12° 38 ' 34 " N	98° 39 ' 08 " E	450	30

## Measurement of environmental parameters

The soil and seawater temperatures were measured, using a waterproof thermometer in the field. The soil and water salinity were measured by are fractometer. Soil pH was measured by using pH meter. Each of the environmental parameter was evaluated and recorded at the start point and end point of all transects in the study sites.

## Results and discussion

Species classification and composition of mangroves in the study sites are shown in Tables 2 and 3, while the environmental parameters are presented in Table 5. A total of 21 species belonging to 11 genera from 9 families of major mangrove plants were recorded in the present study. There were 8 species from family Rhizophoraceae, 3 species

from Avicenniaceae, 2 species from Sonneratiaceae, Meliaceae and Steruliaceae, 1 species from Euphobiaceae, Myrsinaceae, Aracaceae and Plumbaginaceae each (Figure 3). In the present study, 17 species of true mangroves were found in Kapa, 15 species in Masanpa and Panadoung, 14 species in Kywe Ka Yan and 12 species in Kyauk Phyar in this order. *Rhizophora apiculata*, *R. mucronata* and *Avicennia alba* represents the most dominant species, whereas *Bruguiera gymnorhiza* and *Heritiera littoralis* rarely distributed in the study sites. The highest number of species was observed in Kapa, whereas the lowest number of species was in Kyauk Phyar (Table 3). In the present study, the zonation of the number of mangrove species was clearly observed in the Kapa and Masanpa mangroves where other study sites did not significantly differ. The distribution trends of recorded species along the transects in all study sites were presented in Table 4 and zonal distribution of number of mangrove species was shown in Figure 4.

**Table 2** A classified list of true mangrove plant species in the study sites

Sr. No.	Species	Family	Habit	Local name
1.	<i>Rhizophora apiculata</i>	Rhizophoraceae	Tree	Payon-Apho
2.	<i>R. mucronata</i>		Tree	Payon-Ama
3.	<i>Bruguiera gymnorhiza</i>		Tree	Saung-Pho
4.	<i>B. sexangular</i>		Tree	Saung-Pin
5.	<i>B. cylindrica</i>		Tree	Byuu, Saung
6.	<i>B. parviflora</i>		Tree	Saung-Nge
7.	<i>Ceriops tagal</i>		Shrub	Baing-Dough
8.	<i>C. decandra</i>		Shrub	Ka-Pyaing
1.	<i>Avicennia alba</i>	Avicenniaceae	Tree	Thame-Net
2.	<i>A. officinalis</i>		Tree	Thame-Net
3.	<i>A. marina</i>		Tree	Thame-Net
1.	<i>Xylocarpus granatum</i>	Meliaceae	Tree	Pinle-Ohnn
2.	<i>X. moluccensis</i>		Tree	Kyat-Nan
1.	<i>Sonneratia graffithii</i>	Sonneratiaceae	Tree	Lanbu
2.	<i>S. alba</i>		Tree	Lanbu
1.	<i>Heritiera formes</i>	Sterculiaceae	Tree	Kanazo
2.	<i>H. littoralis</i>		Tree	Kanazo
1.	<i>Aegialitis rotundifolia</i>	Plumbaginaceae	Shrub	Padan-Pin
1.	<i>Aegiceras corniculatum</i>	Myrsinaceae	Shrub	Butalet, Kaya
1.	<i>Excoecaria agallocha</i>	Euphorbiaceae	Tree	Tayaw
1.	<i>Nypa fruticans</i>	Aracaceae	Palm	Dani-Pin

**Table 3** Species distribution of mangrove plants in the study sites

Sr. No.	Species	Study sites				
		Kapa	Masanpa	Kywe Ka Yan	Kyauk Phyar	Panadoug
1.	<i>Rhizophora apiculata</i>	+	+	+	+	+
2.	<i>R. mucronata</i>	+	+	+	+	+
3.	<i>Bruguiera gymnorhiza</i>	-	+	-	-	-
4.	<i>B. sexangular</i>	-	-	+	-	+
5.	<i>B. cylindrica</i>	-	+	+	-	-
6.	<i>B. parviflora</i>	+	+	+	-	+
7.	<i>Ceriopstagal</i>	+	+	+	-	+
8.	<i>C. decandra</i>	+	+	+	-	+
9.	<i>Avicennia alba</i>	+	+	-	+	+
10.	<i>A. officinalis</i>	+	+	+	+	+
11.	<i>A. marina</i>	+	+	-	+	+
12.	<i>Xylocarpus granatum</i>	+	-	+	-	-
13.	<i>X. moluccensis</i>	+	-	-	+	+
14.	<i>Sonneratia graffithii</i>	+	+	-	+	-
15.	<i>S. alba</i>	+	+	+	+	+
16.	<i>Heritiera formes</i>	+	-	+	-	-
17.	<i>H. littoralis</i>	+	-	-	-	-
18.	<i>Aegialitis rotundifolia</i>	-	+	-	+	+
19.	<i>Aegiceras corniculatum</i>	+	+	+	+	+
20.	<i>Excoecaria agallocha</i>	+	-	+	+	+
21.	<i>Nypa fruticans</i>	+	+	+	+	+
Total		17	15	14	12	15

Symbols: (+) = present, (-) = absent

**Table 4** Distribution of mangrove plant species along the transect lines

Sr. No.	Species	Study sites														
		Kapa			Masanpa			KyweKa Yan			KyaukPhyar			Panadoug		
		T 1	T 2	T 3	T 1	T 2	T 3	T 1	T 2	T 3	T 1	T 2	T 3	T 1	T 2	T 3
1.	<i>Rhizophora apiculata</i>	+	+	+	+	+	-	-	+	-	-	+	+	+	+	-
2.	<i>R. mucronata</i>	+	+	+	+	+	-	+	+	-	-	+	+	+	+	-
3.	<i>Bruguiera gymnorhiza</i>	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
4.	<i>B. sexangular</i>	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-
5.	<i>B. cylindrica</i>	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-
6.	<i>B. parviflora</i>	-	+	-	+	+	-	+	-	-	-	-	-	+	-	-
7.	<i>Ceriops tagal</i>	-	-	+	+	-	-	+	+	+	-	-	-	+	+	-
8.	<i>C. decandra</i>	-	-	+	-	+	-	+	-	-	-	-	-	+	-	-
9.	<i>Avicennia alba</i>	+	+	-	+	+	+	-	-	-	+	+	+	+	+	+
10.	<i>A. officinalis</i>	-	+	+	+	+	+	+	+	+	+	+	+	-	+	+
11.	<i>A. marina</i>	+	-	-	+	+	+	-	-	-	+	+	+	+	-	-

Table Continued...

Sr. No.	Species	Study sites														
		Kapa			Masanpa			KyweKa Yan			KyaukPhyar			Panadoung		
		T 1	T 2	T 3	T 1	T 2	T 3	T 1	T 2	T 3	T 1	T 2	T 3	T 1	T 2	T 3
12.	<i>Xylocarpus granatum</i>	-	+	+	-	-	-	-	+	+	-	-	-	-	-	-
13.	<i>X. moluccensis</i>	-	-	+	-	-	-	-	-	-	+	-	-	-	-	+
14.	<i>Sonneratia graffithii</i>	-	-	+	+	-	+	-	-	-	-	-	+	-	-	-
15.	<i>S. alba</i>	+	+	+	+	-	+	-	-	+	-	+	-	-	-	+
16.	<i>Heritiera formes</i>	-	-	+	-	-	-	+	+	+	-	-	-	-	-	-
17.	<i>H. littoralis</i>	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
18.	<i>Aegialitis rotundifolia</i>	-	-	-	+	+	+	-	-	-	+	+	+	-	+	+
19.	<i>Aegiceras corniculatum</i>	+	+	-	+	+	-	-	-	+	-	+	+	+	-	-
20.	<i>Excoecaria agallocha</i>	-	-	+	-	-	-	-	+	+	+	-	-	-	-	+
21.	<i>Nypa fruticans</i>	-	-	-	+	-	-	-	+	+	+	+	-	-	-	+
Total		6	9	12	14	9	6	8	8	7	7	9	8	6	9	8

Abbreviations: T 1 = Shoreline, T 2 = Seaward, T 3 = Landward

Table 5 The environmental parameters in the mangrove area during the study period

Sr. No.	Study areas	Salinity (‰)		Temperature (°C)		Soil pH
		Seawater	Soil	Seawater	Soil	
		1.	Kapa	30.0	33.0	
2.	Masanpa	29.6	29.0	29.0	28.3	6.0
3.	Kywe Ka Yan	25.0	25.0	30.0	27.7	6.0
4.	Kyauk Phyar	28.0	29.0	28.0	27.6	6.0
5.	Panadoung	30.0	28.7	32.0	31.4	5.8

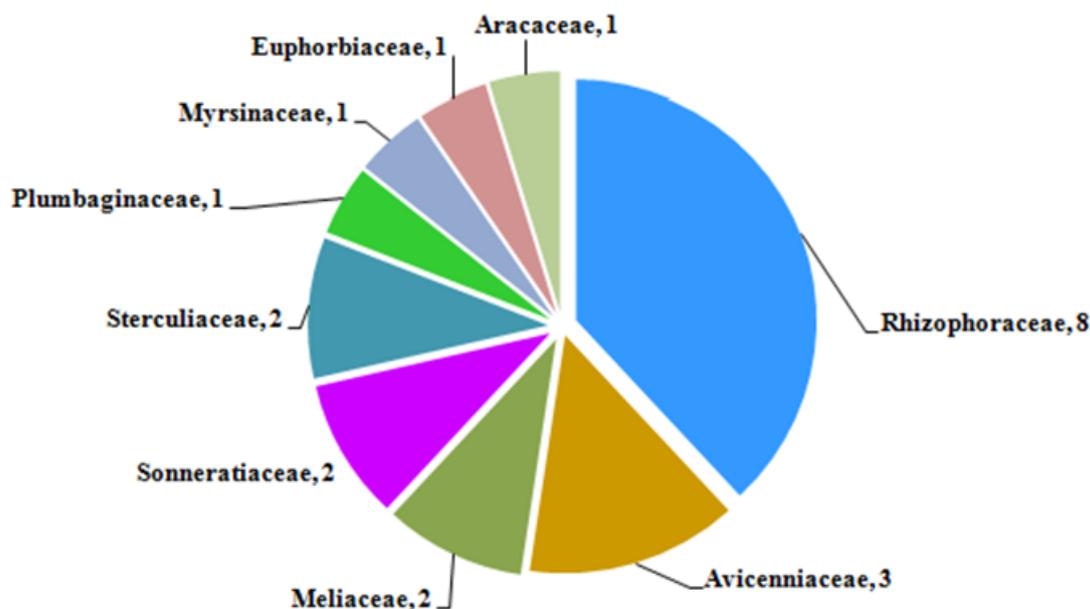
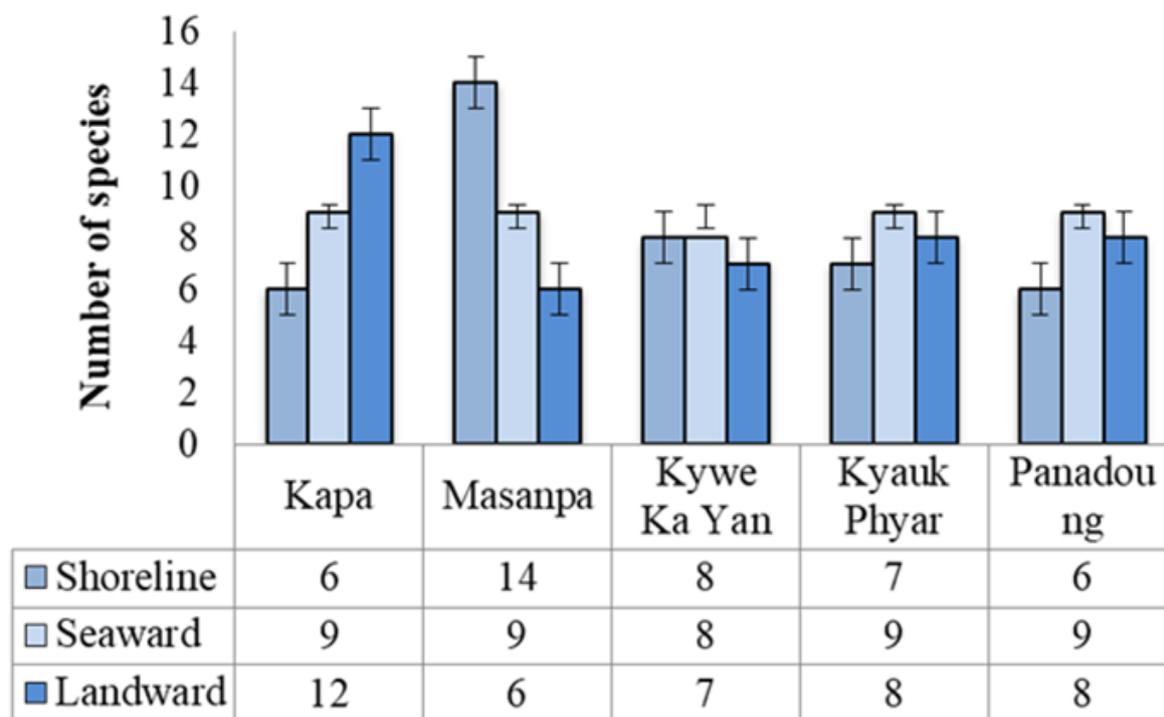


Figure 3 True mangrove families and their abundances in the study area.



**Figure 4** Species composition and zonal distribution of the number of mangroves.

*Rhizophora apiculata* and *R. mucronata* were the most dominant species in the study sites, especially in the seaward areas, whereas *Avicennia officinalis*, and *A. alba* were the most commonly distributed species, and *Bruguiera gymnorrhiza* and *Heritiera littoralis* represented the rarely distributed species during the entire study (Table 4). Among the recorded species, *Aegiceras corniculatum*, *Avicennia officinalis*, *R. apiculata*, *R. mucronata*, *Sonneratia alba* and *Nypa fruticans* were distributed in all study sites. *Rhizophora apiculata* and *R. mucronata* preferred the shoreline and sea ward habitats. Moreover, *Bruguiera parviflora*, *A. corniculatum* and *Nypa fruticans* preferred the seaward habitats, while *Ceriops tagal*, *Sonneratia graffithii*, *S. Alba* and *Aegialitis rotundifolia* preferred the land ward habitats as well.

#### Kapa

A total of 17 species of mangrove were distributed in Kapa (Table 4). *Rhizophora apiculata* was common in all transects. Six species of mangrove-*Aegicera scorniculatum*, *Avicennia alba*, *A. marina*, *R. apiculata*, *R. mucronata* and *Sonneratia abal* were distributed in shoreline areas whereas *Aegicera scorniculatum*, *Avicennia alba*, *A. marina*, *R. apiculata*, *R. mucronata* and *Sonneratia abal* were distributed in shoreline areas whereas nine species of mangrove namely *A. corniculatum*, *A. officinalis*, *A. alba*, *Bruguier aparviflora*, *R. apiculata*, *R. mucronata*, *S. alba*, *Xylocarpus granatum* and *Nypa fruticans* were distributed in the seaward areas and then twelve species of *A. officinalis*, *Ceriops decandra*, *C. tagal*, *Excoecaria agallocha*, *Heritiera formes*, *H. littoralis*, *R. apiculata*, *R. mucronata*, *S. alba*, *S. graffithii*, *Xylocarpus granatum* and *X. moluccensis* were found at the landward area.

#### Masanpa

A total of 15 species of mangrove were distributed in Masanpa (Table 4). *Aegialitis rotundifolia*, *Avicennia alba*, *A. marina* and *A. Officinalis* were found in all transects. All of recorded species

were found in the transect 1 except *Ceriops decandra*. Nine species, namely *Aegiaceras corniculatum*, *A. rotundifolia*, *Avicennia alba*, *A. marina*, *A. officinalis*, *Bruguiera parviflora*, *C. decandra*, *Rhizophora apiculata* and *R. mucronata* were found at seaward area. Six species of *A. rotundifolia*, *A. alba*, *A. marina*, *A. officinalis*, *Sonneratia alba* and *S. graffithii* were found in the landward area.

#### Kywe Ka Yan

A total of 14 species of mangrove were distributed in Kywe Ka Yan (Table 4). *Avicennia officinalis* and *Rhizophora mucronata* were observed in all transects. Eight species of mangrove such as *officinalis*, *Bruguiera cylindrica*, *B. parviflora*, *B. sexangular*, *Ceriops decandra*, *C. tagal*, *Heritiera forms* and *R. mucronata* were found to be distributed in shoreline areas; eight species of mangrove namely *A. officinalis*, *C. tagal*, *Excoecaria agallocha*, *Heritiera formes*, *Nypa fruticans*, *R. apiculata*, *R. Mucronata* and *Xylocarpus granatum* in the seaward area, and seven species of *Aegiceras corniculatum*, *A. officinalis*, *Excoecaria agallocha*, *H. formes*, *N. fruticans*, *Sonneratia alba* and *X. granatum* were in the landward area.

#### Kyauk Phyar

A total of 12 species of mangrove were distributed in Kyauk Phyar (Table 4). *Aegialitis rotundifolia*, *Avicennia alba*, *A. marina* and *A. Officinalis* were found in all transects. *Excoecaria agallocha* and *Xylocarpus moluccensis* were found only in the shoreline area. *Sonneratia graffithii* was found in the landward area only. Seven species of mangrove such as *Avicennia alba*, *A. officinalis*, *A. marina*, *Xylocarpus moluccensis*, *A. rotundifolia*, *E. Agallocha* and *Nypa fruticans* were distributed in the shoreline, Seven species of mangrove-*Rhizophora apiculata*, *R. mucronata*, *A. alba*, *A. officinalis*, *A. marina*, *S. alba*, *A. rotundifolia*, *Aegiaceras corniculatum* and *Nypa fruticans* were distributed in the shoreline, Seven species of mangrove-*Rhizophora apiculata*, *R. mucronata*, *A. alba*, *A. officinalis*, *A. marina*, *S. alba*, *A. rotundifolia*, *Aegiaceras corniculatum* and *Nypa fruticans*

were in seaward and eight species of mangrove-*Rhizophora apiculata*, *R. mucronata*, *A. alba*, *A. officinalis*, *A. marina*, *Sonneratia graffithii*, *A. Rotundifolia* and *A. Corniculatum* were found in land ward sites.

### Panadoung

A total of 15 species of mangrove were distributed in Panadoung (Table 4). *Avicennia alba* was found in all transects. Six species of mangrove-*A. alba*, *A. marina*, *Aegiceras corniculatum*, *Ceriops tagal*, *Rhizophora apiculata* and *R. Mucronata* were in shoreline areas, nine species of mangrove-*Aegialitis rotundifolia*, *A. alba*, *A. officinalis*, *Bruguiera parviflora*, *B. sexangular*, *C. decandra*, *C. tagal*, *R. apiculata* and *R. mucronata* were in the seaward and nine species of mangrove-*A. officinalis*, *A. alba*, *Nypa fruticans*, *A. rotundifolia*, *Excoecaria agallocha*, *C. decandra*, *Xylocarpus moluccensis* and *Sonneratia alba* were observed in the landward area.

Regarding the environmental parameters, mean level of seawater salinity was the highest in Panadoung and Kapa (30.0‰), followed by Masanpa (29.6‰), Kyauk Phyar (28.0‰) and Kywe Ka Yan (25.0‰) in this order. Mean valued of soil salinity was the highest at Kapa (30.0‰), followed by Masanpa and Kyauk Phyar (29.0‰), Panadoung, (28.0‰) and Kywe Ka Yan (25.0 ‰). The range of mean seawater temperature was 28.0- 32.0°C in the study sites. Mean soil temperature was observed to be the highest in Panadaung (31.4°C) whereas that for other study sites was less than 28.6°C. The value of soil pH was 6.0 in Masanpa, Kywe Ka Yan and Kyauk Phyar, while that of soil pH was 5.8 in the Kapa and Panadaung during the study (Table 5).

Mangrove plants and adjacent mudflats are found in all coastal provinces and are widely distributed across the entire coastline.<sup>6</sup> Cunha-Lignon et al.,<sup>17</sup> pointed out that the individual mangrove species rarely occupy entire estuaries from sea mouth to the tidal limit upstream. Also, Duke<sup>18</sup> mentioned that each of the mangrove species has a preferred up river estuarine location based on its salinity tolerance range. Likewise, the present study revealed that the various salinity ranges significantly controlled the distribution of mangrove plant species in the study sites, extending from the mouth to the head of the Tanintharyi River.

Regarding the soil type, Malar<sup>19</sup> demonstrated that *Avicennia alba*, *Sonneratia alba*, and *Rhizophora mucronata* plants could grow well on all substrate conditions such as muddy, very soft muddy and sandy mud area. This implies that the substrate types have no restrictions on their distribution along Myeik coastal areas. The present study showed the same conditions similar with her results on the distribution of mangroves. In addition, the outcomes of this study displayed similar to that of Nan Htwe Htwe Maung<sup>20</sup> who studied the distribution of mangrove species subjected to varying conditions of salinity concentrations, nutrient levels, substrate structures and tidal movement in Magyi tidal creek.

Because of the rapid development of urban infrastructures such as constructions of buildings and establishment of industrialization, the mangrove area is gradually reduced and degraded as in small size in Kyauk Phyar. In conclusion, there is a need to maintain and manage the mangrove forests in the study sites.

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### Conflicts of interest

The author declares that there is no conflicts of interest.

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### References

1. Borkar MU, Athalye RP, Goldin Q. Salinity induced changes in the leaf anatomy of the mangrove *Avicennia marina* along the anthropogenically stressed tropical creek. *Journal of Coastal Development*. 2009;14(3):191–201.
2. Yuvaraj E, Dharanirajan K, Jayakumar S, et al. Distribution and zonation pattern of mangrove forest in Shoal Bay Creek, Andaman Islands, India. *Indian Journal of Geo Marine Sciences*. 2017;46(3):597–604.
3. Kathiresan K, Bingham B. Biology of mangroves and mangrove ecosystems. *Advances in Marine Biology*. 2001;40:81–251.
4. Myint Pe. 2002. National report of Myanmar on the sustainable management of the Bay of Bengal Large Marine Ecosystem (BOBLME). *GCP/RAS/179/WBG*. 2002; 61 p.
5. Kyaw Saw Lynn. Burma (Myanmar). In: Bird E.C.F editor. Encyclopedia of the world's coastal land form. *Springer Science+Business Media B.V*. 2010;1081–1085.
6. Zockler C, Aung C. The mangroves of Myanmar. In: Gul B, editor. *Sabkha Ecosystems, Task for Vegetation Science VI, Springer Nature Switzerland*. 2019;16:253–268.
7. San Tha Tun, Tint Swe, Tint Tun. *The preliminary study on the mangrove of Lampi Island and adjacent areas*. Myanmar. 2008; 18 p.
8. San Tha Tun, Win Hteik, Kyaw Thura. 2014. *Survey of mangroves in Auckland Bay and adjacent areas, Kyun-Suand BokePyin Townships, Tanintharyi Region, Myanmar*. 2014; 28 p.
9. Pyae Sone Aung. *Mangroves of Shwe Bay Area, Myeik, Tanintharyi Region*. Unpublished MSc Thesis, Department of Marine Science, Myeik University, Myanmar. 2015; 86p.
10. Tin-Zar-Ni-Win, Tin-Tin-Kyu, Soe-Win U. Diversity and distribution of true mangroves in Myeik coastal areas, Myanmar. *Journal of Aquaculture & Marine Biology*. 2019;8(5):154–161.
11. Moses S, Zockler C. *Avifauna of the northern Myeik Archipelago, Tanintharyi Region*. Report on Historic and new surveys along the coast of southern Myanmar. 2015; 35p.
12. Zockler. *The bird fauna of the southern Myeik coast, Report on Historic and new surveys in the Tanintharyi coast of southern Myanmar*. 2016; 53 p.
13. Friess DA, Yando ES, Abuchahla GMO, et al. Mangroves give cause for conservation optimism, for now. *Current Biology Magazine*. 2020;30(4):R135–R158.
14. Green Network. *Study on Mangrove deforestation in Kyun Su*. Report of Green Network. 2015; 14 p.

15. Dahdouh Guebas F, Koedam N. Empirical estimate of the reliability of the use of the Point Center Quarter Method (PCQM), Biocomplexity Research Team, Laboratory of General Botany and Nature Management. *Forest Ecology and Management*. 2006; 228(1–3):1–18.
16. Cintron G, Novelli YS. Method for studying mangrove structure. The mangrove ecosystem: research methods, UNESCO, 1984. 91–113.
17. Cunha-Lignon M, Coelho C, Almeida R, et al. Characterization of mangrove forest types in view of conservation and management, a review of mangals at the Cananeia region. Sao Paulo State, Brazil, 2011; p–349–353.
18. Duke NC. *Australia's mangroves. The authoritative guide to Australia mangrove plants*. University of Queensland, Brisbane, 2006; 200 p.
19. Nan Htwe Htwe Maung. *Zonation patterns of mangrove in Magyi tidal creek*. Unpublished MSc Thesis, Department of Marine Science, Patheingyi University, Myanmar. 2011;40 p.
20. Malar, *Morphology and ecology of mangroves and associate in Myeik coastal zone*. Unpublished PhD Dissertation, Department of Botany, University of Yangon, Myanmar. 2009; 169 p.