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Diversity of Seagrasses in Shwe Thaung Yan Coastal Area, Ayeyarwady Region, Myanmar

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Abstract
Seagrasses take part in many important roles of marine biodiversity such as nursery habitat, protective habitat, direct food source and nutrient cycling. The diversity of seagrasses was determined in the seagrass meadows along the Shwe Thaung Yan coastal area, Ayeyarwady Region, Myanmar. Four stations (M1, M2, W1 and P1) were established: M1 and M2 stations were located along Magyi coast at Latitude 17°03'42.5"N, Longitude 094°27'05.7"E and Latitude 17° 04' 14.6"N, Longitude 094° 57' 1.3"E respectively. W1 station was positioned at Latitude 17°08'32.2"N, Longitude 094°27'41.9"E in Wetthay bay. P1 station was set at Latitude 17° 09' 56.9" N, Longitude 094°29' 42.2"E in Phoe Htaung bay. A total of nine seagrasses from the families of Cymodoceaceae and Hydrocharitaceae were recorded in the stations. One-way ANOVA analysis showed a significant difference ($p<0.05$) in Shannon diversity values among the stations. The highest diversity was observed at W1 station (1.63524 (H')). The results showed that there were no highly dominant seagrasses in the stations, which were made up of multi-specific seagrass meadows. The evenness index revealed that there were differences among the stations with the seagrass found in W1 station having the highest evenness (J'=0.84035). *Thalassia hemprichii* was observed as a dominant species in Magyi (M1 station) and Wetthay Bay.

Ke ywords
Diversity, dominance, seagrass, Ayeyarwady Region, Myanmar

1. Introduction

Seagrasses are marine angiosperm permanently or temporarily submerged in the sea (Uku, 2005). The global species diversity of seagrass is nearly 60 species of seagrass which belong to four families of seagrass (Cymodoceaceae, Hydrocharitaceae, Posidonia-ceae, and Zosteraceae) (den Hartog, 2006). Seagrass meadows can form mono-specific meadows, or multi-specific meadows, which may comprise a mix of growth forms (Green and Short, 2003).

Seagrasses consist of (1) adventitious roots that arise from the lower surface of the rhizomes, (2) rhizome and stems which provide function for anchoring, mechanical support, nutrient storage, and regulation and maintenance of vegetative growth, and (3) foliage leaf, that usually forms a unit of several leaves, and normally is referred to as a shoot (den Hartog, 2006). Most seagrass species have converged to a form of flexible, narrow, unbranched leaves arising from the rhizome, but with a considerable range of leaf lengths (Durate, 1991), from a few centimeters (*Halophila* spp.) to several meters (*Zostera caulescens*).

Seagrass beds enhance the marine environment by increasing the amount of physical structure and consequently, increasing the abundance and diversity of marine organisms (Bostrom et al., 2006). The survival of some endangered tropical species such as Sirenia (manatees and dugongs) and green sea turtles is linked to the presence of meadows of seagrasses (Short et al., 2007). Seagrass meadows also support coral reef ecosystems by filtering and precipitating pollutants (den Hartog, 2006). Seagrasses are one of the most threatened ecosystems on Earth with loss rates comparable to those of mangroves, coral reefs, and tropical rainforests (Short et al., 2016).

There are six global seagrass bioregions: four temperate and two tropical. The two tropical bioregions are the Tropical Atlantic and the Tropical Indo-Pacific, both supporting

mega-herbivore grazers, including sea turtles, dugong, and manatee (Short et al., 2016).

The highest primary productivity of the seagrasses is found in the Indo-Pacific region (Hemminga and Duarte, 2000), including Myanmar coastal waters. Soe-Htun et al. (2017) reported that a total of 11 seagrasses were known from the Myeik Archipelago and Rakhine Coastal area. Shwe Thaung Yan coastal area is situated in Ayeyarwady Region along the Rakhine Coastal Region. The objective of the present study was (1) to describe the taxonomy and occurrence of seagrasses found in the stations, (2) to determine the diversity of seagrasses among the stations, and (3) to observe the level of dominancy through the stations.

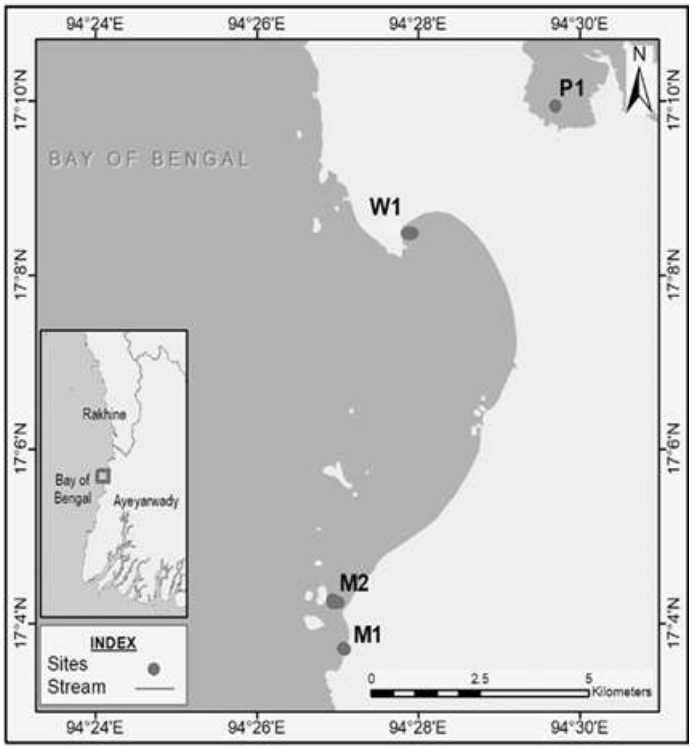

Fig.1. Map showing seagrass sampling stations in Shwe Thaung Yan Coastal area, Myanmar

2. Materials and Methods

2.1. Study Area

The present study was conducted in the Shwe Thaung Yan coastal area, Ayeyarwady Region that is the southern part of the Rakhine Coastal Region in Myanmar. A total of four stations were established along the Shwe Thaung Yan coastal area. Two stations were located along the Magyi (M) coast: the coordinate point of M1 station is Latitude 17°03'42.5"N, Longitude 094°27'05.7"E, and M2 station is at Latitude 17° 04' 14.6"N, Longitude 094° 57' 1.3"E. Both Wetthay bay (W) and Phoe Htaung bay (P) had single stations: W1 station was positioned at Latitude 17°08'32.2"N, Longitude 094°27'41.9"E, and P1 station was placed at Latitude 17° 09' 56.9" N, Longitude 094°29' 42.2"E (Fig. 1).

Seagrass meadows grow on the substrate of gravel and sand among the shelter of rocky intertidal areas except the station in Phoe Htaung bay where the seagrass meadows grow on soft substrates. The seagrasses are exposed at low tide at M1 and P1 station however the seagrasses grow in the subtidal zone at M2 and W1 station.

2.2. Sampling Methods and Data Analysis

Samplings were conducted during the Southwest monsoon period in 2024 (May-October). The cross-transect was done in the stations based on standard monitoring methods using Seagrass Net protocols (Short et al., 2015). Three lines of 50 m transect were set up parallel to the shore, 25 m apart. To estimate the diversity of seagrasses in the station, a 25 cm quadrat (area 0.0625 m^2) was randomly placed three times in every transect line for collecting the seagrass samples (hence n=9 for each site). The samples in the quadrat were collected digging with a shovel then the collected seagrass samples were rinsed under the tap to remove sediment particles and other epiphytic organisms. The leaf tips of seagrass species were determined under Microscope (Olympus SZ 51 dissecting microscope, 10x magnification). Seagrass specimens were identified according to Miki (1932), Lanyon (1986), Fortes (1993) and Kuo and den Hartog (2001).

The ecological indices, the diversity index (H'), species richness index (D), species evenness index (J'), dominance index (D) were determined as follows. Species dominance in every station was determined in PAST 4.13 software.

2.3. Species Diversity, Evenness and Richness

The diversity of seagrasses was determined using the Shannon-Weiner diversity index (Zar, 2010). A greater number of species means higher species diversity, and a more even or equitable distribution among species will also give a higher Shannon-Wiener index of species diversity (Krebs, 2001). The quantity J' has been termed evenness (Pielou,

1966) and may also be referred to as homogeneity or relative diversity (Zar, 2010). Evenness, or equitability, is the uniformity of abundance in an assemblage of species (Nolan and Callahan, 2006). Species richness of seagrass was determined by the Margalaf index.

***Diversity* (Shannon-Weiner, 1948)**

$$H' = -\sum_{i=1}^{n} p_i x \log p_i \quad (1)$$

where; H': Shannon Diversity Index, $P_i = n_i / N$ (proportion of the -ith species); n_i: Number of individuals of the -ith species; N: Total number of individuals of all species. The diversity index was then categorized as the following criteria: H' > 3 =high diversity;1 ≤ H' ≤3= moderate diversity; H' < 1 = low diversity.

***Evenness* (Pielou, 1966)**

It can be defined as the ratio:

$$J' = \frac{H'}{H_{max}} \quad (2)$$

where; J' =evenness (range 0–1), H= observed species diversity, H_{max} = maximum species. Diversity calculated as LnS where; S= number of species found, Ln= natural log). Evenness can be defined as the following categories: 1.0 ≥ J' < 0.6 = high equitability; 0.6 ≥ J' > 0.4 = medium equitability; 0.4 ≥ J' ≥ 0 = low equitability.

***Species Richness Index* (Margalaf, 1958)**

$$D = \frac{S-1}{LnN} \quad (3)$$

where; D= species richness, S= total number of species in a habitat, N= number of individuals in a habitat.

***Dominance Index* (Simpson, 1949)**

The dominance values of seagrass species were analyzed by following Simpson's dominance index (1949) (Brower et al., 1990):

$$D = \sum_{i=1}^{s} \left(\frac{N_i}{N}\right)^2 \quad (4)$$

where; D: Simpson's dominance index, N_i: Number of individuals of the –ith species, N: Total number of individuals of all species

When there is an increase D, there will be a decrease in the value of evenness (J') (Brower et al., 1990). Then, the dominance index criteria can be described as the following categories: 0.6 < D ≤ 1.0 = high dominance; 0.4 < D ≤ 0.6 = moderate dominance; 0 ≤ D ≤ 0.4 = low dominance.

Table 1. Species composition and occurrence of seagrasses at four stations in Magyi, Wetthay bay and Phoe Htaung bay, Shwe Thaung Yan Coastal Area, Myanmar, in 2024.

No	Species	M1	M2	W1	P1	Total station
1	*Syringodium isoetifolium*	+	-	+	-	2
2	*Halodule pinifolia*	+	+	+	+	4
3	*H. uninervis*	+	+	+	+	4
4	*Cymodocea rotundata*	+	+	+	+	4
5	*C. serrulata*	+	+	+	+	4
6	*Enhalus acoroides*	-	-	-	+	1
7	*Thalassia hemprichii*	+	+	+	-	3
8	*Halophila major*	-	+	-	-	1
9	*H. ovalis*	-	-	+	-	1
	Total species	6	6	7	5	

Table 2. Values of ecological indices of seagrasses at four stations in Shwe Thaung Yan Coastal Area, Myanmar found in 2024

Ecological Index	M1	M2	W1	P1
Diversity-H'	1.16146	1.33513	1.63524	0.95623
Richness - D	0.91933	0.84918	1.0823	0.69527
Evenness- J'	0.64822	0.61717	0.84035	0.59414
Dominance- D	0.41392	0.39861	0.22199	0.48945

3. Results and Discussions

3.1. Taxonomy and Species Composition of Seagrasses

A total of nine seagrass species were observed in four stations belonging to the two families, Cymodoceaceae, and Hydrocharitaceae (Figs. 2-3). Under the Cymodoceaceae family, *Syringodium isoetifolium, Halodule uninervis, H. pinifolia, Cymodocea rotundata*, and *C. serrulata* were observed. Under the Hydrocharitaceae family, *Thalassia hemprichii, Enhalus acoroides, Halophila major,* and *H. ovalis* were recorded. Six seagrasses*: Syringodium isoetifolium, Halodule uninervis, H. pinifolia, Cymodocea rotundata, C. serrulata*, and *Thalassia hemprichii* were found in M1 station. Similarly, M2 station had six seagrass species although *Halophila major* was observed instead of *S. isoetifolium*. The other species were the same in both stations.

3.2. Ecological Indices of Seagrasses

A difference of diversity among the four stations was determined by using Shannon-Weiner function. One-way ANOVA analysis showed a significant difference ($p<0.05$) in Shannon diversity values among the stations ($p=0.01$). The highest diversity value was recorded at W1 station (H' = 1.64)

that is a moderate diversity as the seven seagrasses in that community were highly evenly distributed (J'= 0.84), furthermore the species dominancy was also low. The seagrass at P1 station in Phoe Htaung bay had the lowest diversity value (H' = 0.96) among the stations although species evenness and dominance were moderate values. Both stations: M1 and M2 in Magyi had moderate values in diversity, evenness, and dominance. The diversity of seagrasses found in M1 and M2 station didn't differ significantly (p=0.6). By the criteria of diversity index, the values of diversity in all stations were moderate to low diversity that the range was from 0.96 (H') to 1.64 (H') (Table 2). W1 station had the highest species richness among the stations, then followed by M1 station whereas P1 station had the lowest species richness (Table 2). The evenness or species equitability of W1 station was highest among the stations. According to the criteria of equitability index categories, the value of W1 station: 1.08 (J') approaches high equitability but the values of other stations are around of moderate evenness ($0.6 \geq J' > 0.4$). The values for dominance found in all stations were in a range between moderate and low dominancy (Table 2).

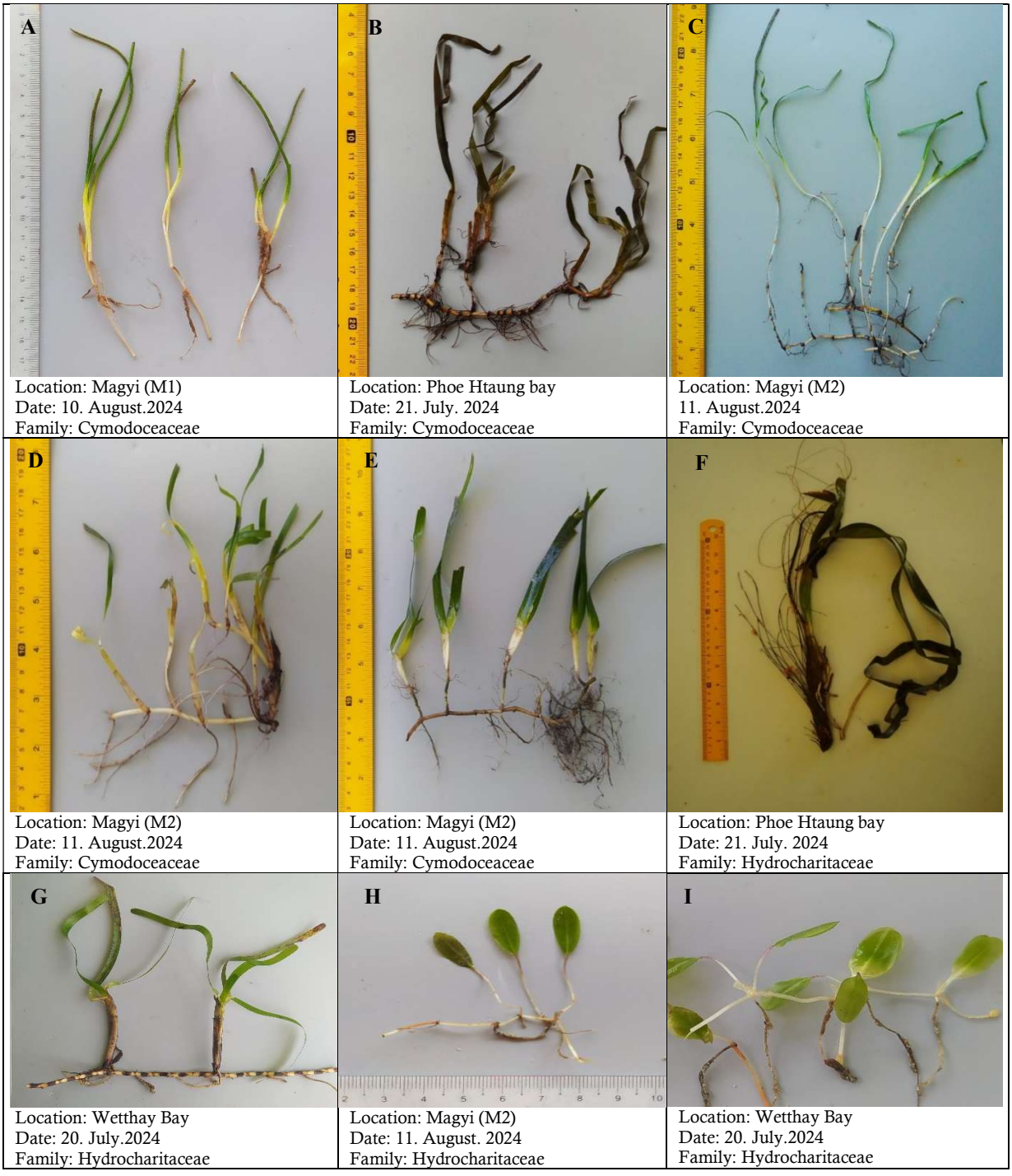

Fig. 2. Seagrasses found in Magyi, Wetthay bay and Phoe Htaung bay, Shwe Thaung Yan Coastal Area, Myanmar, in 2024: (A) *Syringodium isoetifolium*; (B) *Halodule uninervis*; (C) *H. pinifolia*; (D) *Cymodocea rotundata*; (E) *Enhalus acoroides*; (F) *Cymodocea serrulata*; (G) *Thalassia hemprichii*; (H) *Halophila major*; (I) *H. ovalis*

3.3. Dominance of Seagrasses

In the results of Simpson Dominance Index (1-D) showed the dominance by the species in the seagrass community across four stations: M1, M2, W1, and P1 (Fig. 3). In Magyi, *Thalassia hemprichii* was highly dominant at M1 station although *Cymodocea serrulata* was common at M2 station but the abundance of *T. hemprichii* was relatively low.

The dominant species observed in W1 station was *T. hemprichii* as similar as M1 station whereas *Halophila ovalis* was recorded as low abundance. *Halodule pinifolia* and *H. uninervis* were prevalent than other species at P1 station while *Enhalus acoroides* was the least dominant species occurring as a clump of small scale not continuous. Four dominant species: *Thalassia hemprichii, Cymodocea serrulata, Halodule uninervis*, and *Halodule pinifolia* were found in the present study. The present study obtained a total of nine seagrasses at the four stations although previous researchers documented 10 species in Shwe Thaung Yan coastal area.

A total of 11 species of seagrasses were previously recorded through 14 sites along Rakhine coast and within Myeik Archipelago in Myanmar (Soe-Htun et al., 2017). Gole et al. (2023) described 11 seagrasses: *Syringodium isoetifolium, Halodule uninervis, H. pinifolia, Cymodocea rotundata, C. serrulata, Enhalus acoroides, Thalassia hemprichii, Halophila baccarii, H. decipiens, H. ovalis,* and *H. minor* found in the Andaman and Nicobar Islands in India.

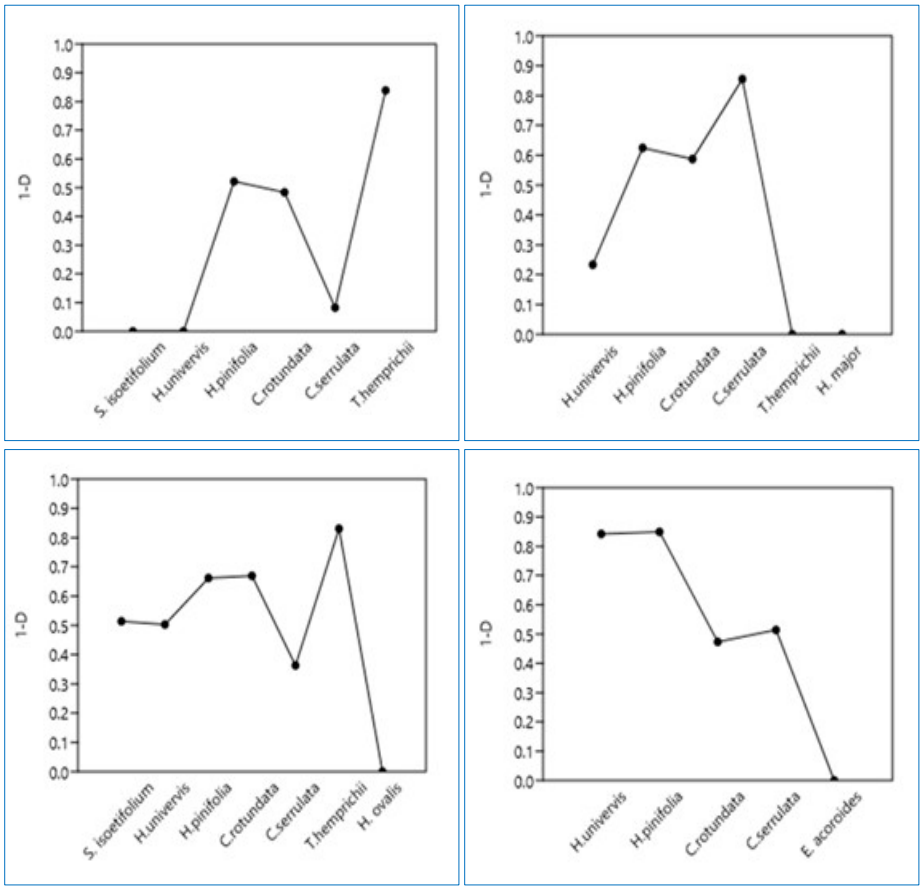

Fig. 3. Simpson Dominance Index (1-D) of seagrasses found at four stations: M1, M2, W1, and P1 in Magyi, Wetthay bay, and Phoe Htaung bay, Myanmar, 2024 with Past 4.13 software

A total of seven seagrasses were observed at two stations (M1 and M2) in Magyi but Soe-Htun et al. (2017) recorded eight species at 17°.072122" N 094°.451406" E in Magyi area. Rein (2019) had described six species in Inn Din Gyi (M2 station in the present study) however *H. pinifolia* was not recorded.

Htut (2011) studied the species composition and distribution of seagrasses in Shwe Thaung Yan coastal area and recorded eight species in Magyi, seven seagrasses in Wetthay bay and ten species in Phoe Htaung bay. In this study, seven seagrass species were observed in W1 station, those are *S. isoetifolium, H. uninervis, H. pinifolia, C. rotundata, C. serrulata, T. hemprichii* and *H. ovalis*, and five species of seagrass: *H. uninervis, H. pinifolia, C. rotundata, C. serrulata,* and *Enhalus acoroides* were found at P1 station.

A range of seagrass diversity observed from the present study was between 0.96 (H') and 1.64 (H'); however, Eraniati et al. (2023) found a range from 1.02 (H') - 1.28 (H') at all stations in Palau Banyak in Aceh Singkil District, Indonesia. In addition, Aboud and Kannah (2017) observed the diversity of seagrass species in the Lagoonal Reefs on the Kenyan coast in Vietnam that was a range from 0.56 (H') to 1.16 (H'). The species diversity of seagrasses in Magyi and Phoe Htaung Bay showed the highest in the Rakhine Coastal Region, Myanmar (Table 1) (Soe-Htun et al., 2017).

Halophila ovalis was low abundance only found in Wetthay bay from the present study although it was extensively observed in the Myeik Archipelago, Myanmar (Soe-Htun et al., 2017). In the current study, *Thalassia hemprichii* was dominant in two stations (M1 and W1); likewise, Mascariñas and Otadoy[24] found *Thalassia hemprichii* was very dominant and extensive distribution across the sampling stations in Maribojoc Bay, Bohol, Philippines.

Species composition and diversity varied depending on the location as all stations are multi-specific seagrass meadows. As the samples were total species from 0.5625 m^2 area at each station, the number of species actually occurring in the region is likely to be considerably higher. Further research is needed with more sampling stations to determine the true diversity of the seagrasses in the region.

4. Conclusions

The four stations established in three locations, namely Magyi, Wetthay bay, and Phoe Htaung bay were found to have a total of 9 seagrass species. The species richness was high at W1 station in Wetthay bay whereas Phoe Htaung's station had low species richness. The seagrass meadow in Wetthay bay was not only high diversity with high evenness but also less species dominance. The species *Thalassia hemprichii* was dominant among other species in two stations: M1 and W1. The paddle leaf grasses of genus *Halophila* were found to be the low dominant species observed at Magyi (M2) and Wetthay bay. In conclusion, the results of ecological indices showed that the seagrass meadows in Shwe Thaung Yan coastal area exist in moderately healthy seagrasses. There is a need for further research of seagrasses in Myanmar as there is insufficient information of seagrass research data to inform management.

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