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Condition and zonation of mangrove ecosystems in the small islands around the area crossed by the equatorial line of North Maluku Province

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ABSTRACT

The South Halmahera Islands feature a comprehensive marine coastal ecology. The ecosystems found were seagrass, mangrove and coral reef ecosystems. The components that sustain the existence of this ecosystem are employed equitably because of its geographical location on the equator. Mangrove ecosystems that provide benefits directly and indirectly to the community. The purpose of this study was to determine the condition of the mangrove ecosystem based on the hemispherical photography method and the type of zonation. Tawabi Island, Kayoa, South Halmahera Regency served as the site of the equator research. The research station is determined as many as 3 stations. Mangrove percent cover canopy using the hemispherical photography and transect quadrant for density. Field data gathering procedures with transects drawn perpendicular from the sea to the land. Zonation characteristics and thickness using zone tracking. Density mangrove using ecology analysis and zonation using canvas 9.0. The results of the research founded were *Rhizophora apiculata*, *Rhizophora mucronata* and *Sonneratia alba*. Mangrove percent cover canopy were good category (75-81%), where station I (75%), station II (81%) and station III (77%). Station I having 600 trees per ha, station II having 500 trees per ha, and station III having 400 trees per ha (low density category). Mangroves were found in 3 zones *Sonneratia alba*, *Rhizophora apiculata* and *Rhizophora mucronata*. The mangrove thickness from sea to land at station I (65 meters), station II (69 meters) and station III (42 meters).

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Introduction

North Maluku is an archipelago located on the equator (Purba *et al.*, 2021). Tawabi Island is administratively a part of North Maluku Province's South Halmahera Regency. This island has abundant coastal natural resources. This island is located in the region on the equator (0°). The equatorial latitude that passes through this area makes the region have unique characteristics such as climatic conditions, oceanographic conditions and bioecology that are different from conditions in other areas. Equatorial location can bring about unique variances in the

variety of biota and ecosystem types. The even distribution of mangrove ecosystems can have direct ecological, economic and social impacts on society. The mangrove ecosystem is used as a habitat, feeding area, stopover and enlargement for aquatic and terrestrial organisms, besides that it is also used for building materials, firewoods, medicines, oil traps, protecting beaches from waves, currents and abrasion as well as tourism. (Kathiresan and Bingham, 2001; Hogarth, 2007; Saru, 2009; Lumbessy *et al.*, 2015; Akbar *et al.*, 2017; Akbar *et al.*, 2018).

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Research reports on coastal and marine mangrove ecosystems on Kayoa Island reported by FDC-IPB (2011) showed sufficient and damaged conditions and only certain locations showed good conditions. Ratnawati et al. (2011) conducted research on reef fish, and the findings indicated that the diversity of reef fish was high, and has a strong relationship to the presence of mangroves. Mangrove research has been carried out in North Maluku, namely Akbar et al. (2015) in the coastal area of Sidangoli, West Hamahera based on the level of density of mangrove ecosystems in the low density category (200 trees per ha). Studies on other mangrove ecosystems on Mare Island, Tidore City (Akbar et al., 2016) are in the sparse category. According to ecological indices (species density, -species frequency, species cover -, and importance values), Akbar et al. (2017b) discovered that the Dodinga Bay mangrove forests' community structure was quite good and that the species diversity of the mangroves was in the moderate range. Tahir et al. (2017) reported that the area of mangrove in Jailolo Bay is 393.77 ha with a category of very rare to dense density. In Tewe village, South Jailolo District, where the condition of the mangroves was in the good category and there was a moderate diversity, Akbar et al. (2018) described the structure of the mangrove community in Tewe Village. South Jailolo. Based on high-resolution satellite data, Paembonan et al. (2022) found that the mangrove area on Ternate Island, which was 5.97 ha in 2002, was degraded 2.51 ha in 2022. There are no scientific reports on mangroves in the equatorial area (Tawabi Island). The equator-to-equator differences in environmental traits cause variances in morphological and physiological traits, which may also be sparked by genetic variants. In locations with distinctive characteristics, it is crucial to provide information on the presence and state of mangroves. Further details can offer scientific validity as well as knowledge about Tawabi Island's mangrove environment. The traditional method is used in the survey to describe the overall (landscape) of the mangrove ecosystem in general. Traditional techniques, such as quadratic transects and spot checks, were employed in earlier reports on assessing mangrove quality (Baksir et al., 2018). In an effort to keep the methods utilized up to date, new ways must be used. In Indonesia, a technique called hemispherical photography has been utilized and developed. hemispherical photography has been used in research Dharmawan (2015) conducted research on the application of this strategy in the Savu Sea Marine National Park (TNP), East Nusa Tenggara Province, Dharmawan and Akbar (2016)

reported that in the Gili Matra Water Tourism Park, North Lombok, NTB, Dharmawan and Widyastuti (2017) reported that at West Papua's Wondama Bay, Nurdiansah and Dharmawan (2017) reported that Tidore Island and its surrounds, Baksir et al. (2018) reported that in Minaluli. Area of North Mangoli, Sula Archipelago, Purnama et al. (2020) reported that in Demak, Marassabessy et al. (2021) reported that in Sorong, West Papua, Hamdani et al. (2021) reported that in Kuala and Patty et al. (2022) reported that in East Bolaang Mongondow, North Sulawesi are some examples of the researchers that have worked in the North Maluku Province. Tawabi Island (-0.001847 E, 127.423688 N) does not currently have any publicly available scientific information about studies employing the hemispherical photography approach to characterize the mangrove ecosystem landscape. This information is crucial for giving a general overview of the equatorial region's mangrove ecosystems.

Materials and Methods

Location and time of research

The study was carried out in January-March 2023 on the island of Tawabi in the North Maluku Province Figure 1. The phases of field data collecting, tabulation, and analysis for study. The tools utilized include a Garmin GPS with a 3 mprecision, cannon camera, a roll meter for measuring mangrove transects, and a Horiba multy parameters for measuring water quality (dissolved oxygen, pH, temperature and salinity)

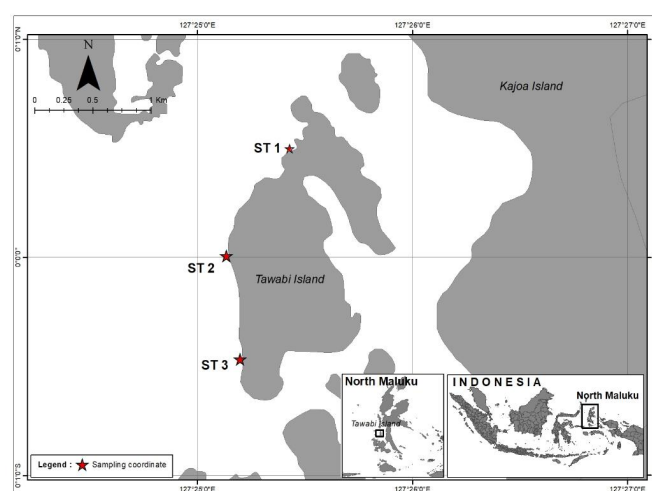


Figure 1. The Research Site in Tawabi Island. Kayoa. North Maluku. Indonesia.

Mangrove and environmental condition

The hemispherical photography method with using a fish-eye lens to view the mangrove percent cover canopy (Dharmawan and Pramudji, 2014). The

use of the hemispherical photography technology in Indonesian mangrove forests is relatively recent.

Mangrove sampling was carried out at three stations. Each station carried out three repetitions of sampling (3 quadrant transects). Mangrove density was measured using the transect quadrant method (Bengen, 2004). The transect station is pushed perpendicular to the land from the ocean (50 meters) and using transect (10 m x 10 m) with 3 tracks a distance of 20 meters between tracks mangrove data was collected for tree (stem) categories. For each tree in the transect region, the stem diameter was measured. Each tree in the transect area had its trunk diameter measured. The diameter of the stem is measured by circling a ruler on the tree trunk. Identification species using guidelines (Noor et al., 2012). The zone tracking approach was used to determine the mangrove zonation and thickness, which was followed by a descriptive description (Koroy et al., 2020). Environmental parameters taken in situ include salinity, temperature, pH and DO.

Data analysis

ImageJ, which can be downloaded for free at <http://imagej.nih.gov/ij/download.html>, was used to evaluate photo shootings. Mangrove density analysis data used the formula (Bengen, 2004). Environmental data is tabulated using *Ms Excel* then tables are made and presented.

Results

Mangrove species composition

Mangrove identification revealed two families and three species (Table 1). The mangrove species discovered are ones that are frequently found in Indonesia's and North Maluku's coastlines. *Rhizophora apiculata* and *Rhizophora mucronata* are members of the *Rhizophoraceae* family. The species

Sonneratia alba is in the family *Sonneratiaceae*. *Rhizophoraceae* has a greater number of species than *Sonneratiaceae*. The capacity of this species to thrive in a range of situations.

In general, this shows that although the *Rhizophoraceae* family has many species, the number of individuals per species found is low Table 2. The number of mangroves at the observation station shows that the *Sonneratiaceae* family, namely the *Sonneratia alba* species, has a large number of trees Table 2.

Canopy coverage of mangrove

The entire analysis reveals that Tawabi Island has a significant percentage of mangrove cover (Figure 2 & Table 3). According to the Decree of the Ministry of Environment No. 201 Year 2004 the mangrove cover value was reached at between 75-81%, indicating that the canopy cover is in a good category Table 2. The percentage of stations I (75%), II (81%), and III (77%), respectively (Table 2). The high percentage at station II is caused by the presence of medium-sized trees with a dense canopy cover of the *S alba* species in this region. The *S alba* tree is large, with many branches and twigs, as well as many leaves, resulting in a high canopy cover.

While there was little anthropogenic logging at Station II, *Sonneratia alba* mangrove trees displayed high levels of fecundity (dense leaves, lots of tree branches and emergence of young leaf buds). The size of the trees with enormous diameters, but few tree branches and a sparse number of leaves are assumed to have an impact on the percentage of canopy cover at station III (77%). Station I have a canopy percentage (75%), due to anthropogenic carried out by the community in this area.

Table 1. Famili, species dan mangrove name (Indonesia dan local)

Number	Family	Species	Indonesia name	Local Name
1	<i>Rhizophoraceae</i>	<i>Rhizophora apiculata</i>	Bakau	Mangi-Mangi
		<i>Rhizophora mucronata</i>	Bakau hitam	
2	<i>Sonneratiaceae</i>	<i>Sonneratia alba</i>	Pedada	Soki-Soki

Table 2. Mangrove total and categories

No	Species	Tree Categories (ha)		
		Station I	Station II	Station III
1	<i>Rhizophora mucronata</i>	10	-	-
2	<i>Rhizophora apiculata</i>	20	-	-
3	<i>Sonneratia alba</i>	570	500	400
	Total	600	500	400

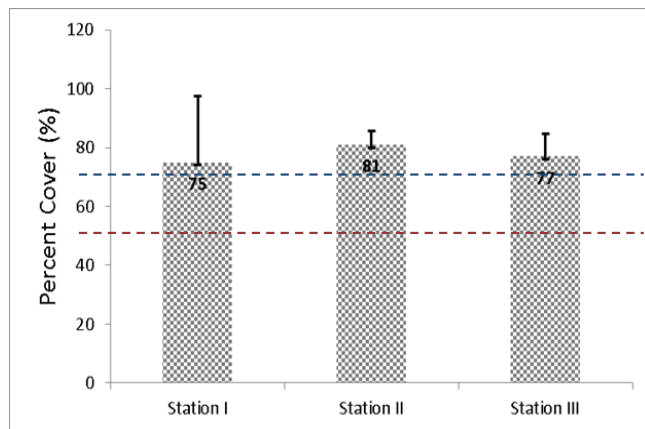


Figure 2. Based on a station utilizing the hemispherical photography method, the mangrove ecosystem canopy cover. Border between solid (cover categories of >75%) and medium (cover categories of >50%), in blue. Boundary between the medium (>50-75%) and low (50%) cover categories is indicated by a red dotted line.

Mangrove density

When comparing the mangrove densities of the various stations, station I has the highest value (600 trees/ha). Despite the diameters of the stems

indicating a small size, there are many *S. alba* individuals in this area. The characteristics of station I, where there are many *S. alba* individuals in the tree category but only short trunk diameters (special characteristic). The measurements of the sea environment's factors generally yielded normal (Table 3), however *S. alba* showed normal tree height but a small trunk diameter. The amount of anthropogenic activity at station I was minimal. Station II has a density value (500 trees/ha) due to the medium-sized mangroves and typical tree spacing present there, as well as the area's wide tree branches and dense foliage, which contribute to the area's high canopy coverage of mangrove. Low density (400 trees/ha) at station III because to the mangroves' huge size, age, and morphological features, which include large tree diameters and uncommonly long growing distances between trees.

The study's findings revealed fresh information, showing that a small island near the equator was home to a dominating mangrove species called *Sonneratia alba* (Tawabi Island. Kayoa Islands. Indonesia). To learn more, research pertaining to organic components in sediments is required. Tawabi Island's environmental measurements indicate that conditions are stable (normal) Table 3. All indicators point to the presence of mangroves along Tawabi Island's coast Table 4.

Table 3. Standard criteria mangrove damage (Minister of Environment No 201 Year 2004)

Criteria		Canopy coverage (%)	Density (tree/ha)
Good	Very Dense	≥ 75	≥ 1500
	Medium	≥ 50 - < 75	≥ 1000 - < 1500
Bad	Sparse	< 50	< 1000

Table 4. Environmental parameters in Pulau Tawabi.Kayoa.North Maluku. Indonesia

No	Area	Parameters	Value	Unit
1	Sea	Temperature	30.8	°C
2		Salinity	34	‰
3		Disolved Oxygen (DO)	6.2	mg/l
4	Land	pH sea	8.1	-
5		pH land	7	-
6		Substrat	Sand	-

Zonation and thickness mangrove

Mangrove zonation found 3 zonations that is *S. Alba*, *R. apiculata*, and *R. mucronata* are described by the mangroves of Tawabi Island (Figure 4). At the 3 research stations, mangrove zoning is generally

similarities (Figure 4). A homogenous zoning is created by the three stations' zoning descriptions. The commonality of coastal physiography, substrate, and oceanographic impacts is suggested to be the cause of the similarities of zoning types.

Tawabi Island's mangrove zone is unique compared to other mangrove zonation patterns. The kind of substrate, coastal terrain, tides, and the distribution of currents and waves may all have an impact on the variances in zoning.

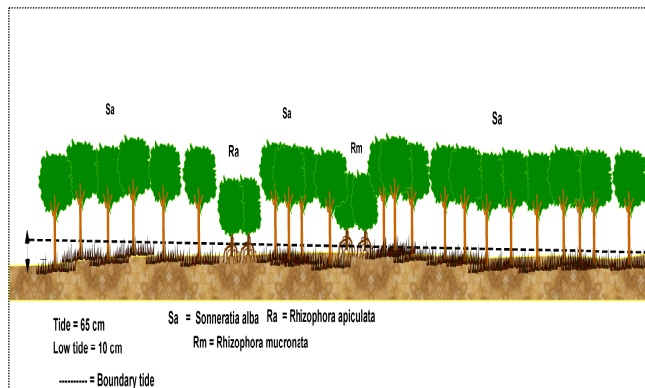


Figure 4. Mangrove zonation in Tawabi Island. Kayoa. North Maluku. Indonesia

It was discovered that mangrove thickness varied between stations [Figure 5](#). We discovered stations I (65 m), II (69 m), and III (42 m) based on the results of the measurements ([Figure 5](#)). Because Station I faces another island, it is situated in a region that tends to be protected, which lowers the effects of tides, waves, and currents. Because Station II is situated in an area that is rather open and does not face the island, the influence of the water is significant. Although Station III is an open location, its sloping beach extends far out into the ocean (150-200 m), making it less affected by oceanographic dynamics.

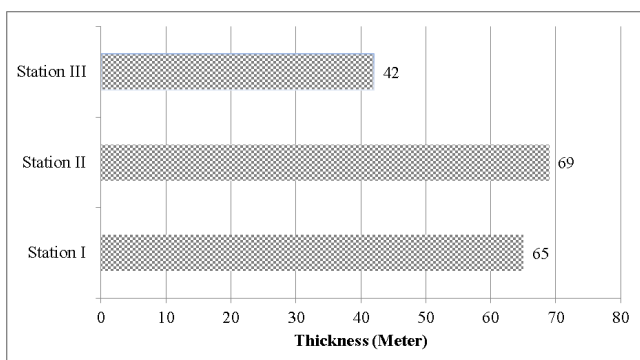


Figure 5. Mangrove thickness in Tawabi Island

Discussion

Station I, which has a muddy sand substrate, is believed to support the existence of the *Rhizophoraceae* family. Stations II and III did not find sand substrate, which is thought to be the absence of the *Rhizophoraceae* family. Stations II and III when the tide is high and at its lowest point, the mangrove forest is still immersed in the ocean at all locations. This

family can develop everywhere because it can adjust to its environment. Large trees are used by the population as firewood and as poles for traditional homes and harbors. In the center of a dense *Sonneratia alba* mangrove habitat, logging was done haphazardly on big, shaded *Sonneratia alba* trees. Natural mortality was also seen in this region, which is likely a result of the *Sonneratia alba* mangroves' advanced old. A research approach in areas crossed by the equator was carried out to see the similarities and differences in mangroves. Research on Tawabi Island shows that there are differences in species composition and dominance. [Lisna et al., \(2017\)](#) reported that the species found in Katulistiwa village, Indonesia were *Sonneratia ovata*, *Rhizophora mucronata*, *Avicennia lanata*, *Xylocarpus moluccensis* and *Acanthus ilicifolius*. *Avicennia lanata* is a species that dominates the mangrove forest area of Katulistiwa village ([Lisna et al., 2017](#)). This difference is thought to be due to habitat character factors, where growth and development is very dependent on regional characteristics. Tawabi Island is a coral island which has a shallow sea area with habitat characteristics of a dominant sand substrate and small areas of muddy sand. This is of course different from Katulistiwa village, Indonesia which is located on the main mainland of Sulawesi Island which also has a large river estuary and delta with lots of water flow. contains mud. Another factor is topography, mineral and rock content will also vary, thus having an influence on the mangrove species that grow.

The discovery of anthropogenic tree felling operations and natural tree deaths offers crucial information for the public and government awareness to carry out conservation initiatives. Because seedlings and tillers don't emerge very frequently, the regeneration process is slowing down. It is feared that this issue would contribute to the extinction of mangrove species on Tawabi Island. It is vital to plant mangroves specifically for the *Sonneratia alba* species on Tawabi Island because elderly, long-lived trees have a limited capacity to survive. It is also believed that the influence of tidal traction and high waves during the west monsoon season contributes to the frequency of discovering low tillers.

The region's ecological, biological, and physiological features encourage the formation of the *Rhizophoraceae* family ([Akbar et al., 2018](#)). Sand and muddy sand make up the substrate in this area, making it ideal for *Rhizophoraceae* growth. Earlier studies in the coastal region of North Maluku revealed that the *Rhizophoraceae* family predominates and spreads uniformly ([Akbar et al., 2015, 2016,](#)

2017a, 2018, 2019; Nurdiansah and Dharmawan, 2018; Baksir et al., 2018; Paembonan et al., 2022). Variation species composition can be found in Indonesia's other equatorial areas, such as Kutai National Park (KNP). Seven families, 17 species of mangroves, and three dominant species *Rhizophora apiculata*, *Rhizophora mucronata*, and *Bruguiera sexangula* can all be found in East Kalimantan (Poedjirahajoe et al., 2019). This variation could be brought on by the islands, the topography of the sea, and other chemical and biological traits.

The enormous quantity is attributable to habitat appropriateness, as sand constitutes the majority of the local substrate. According to many studies (Akbar et al., 2019; Paembonan et al., 2022; Pratiwi et al., 2022), variances in substrate, tidal periods, wave frequency, salt levels, temperature, water pH, soil pH, and dissolved oxygen are assumed to be the root cause of variations in mangrove composition. A sand-based substrate in the area supports the population of *S. alba* as a whole. *S. alba* thrive in locations with sand as their substrate and grow there. The habitat of *S. alba* is characterized by its sand kind of substrate (Tefarani et al., 2019; Prinasti et al., 2020). Lawerissa et al. (2018) reported that who discovered that this species grows in large numbers on sand substrates with sizes of medium sand (0.5 mm), fine sand (0.25 mm), and very fine sand (0.125 mm) on the coast of Negeri Ihamahu, Saparua Island, support *S. alba*'s dominance in the sandy substrate area, Maluku, Indonesia. Family *Sonneratiaceae*, which can survive in harsh settings (low oxygen and mud substrates), is also adaptable (Faizal et al., 2023). This species grows on sandy substrate areas during low tide and high tide due to physiological adjustment of the breathing roots (*pneumatophores*), which readily absorb oxygen.

Equatorial effect, where the climate at this location is significantly different and also plays a role in other natural changes. This region has an anomaly, where the air and sea temperatures are warm throughout the year (normal), but there are times when conditions change and become extreme. These changes may be related to the revolution and position of the sun. Case studies show that mangrove cover could increase significantly near the polar limits of mangrove forests if the frequency of extreme winters is reduced (Tran et al., 2022). The reproductive capacity of mangrove species may be reduced due to warming seasonal climatic conditions. Apart from showing signs of decreasing chlorophyll A and B levels in mangroves planted in the highlands, photosynthesis in mangroves at the equator has also been shown to decrease (Wang et al., 2019). However,

the height and width of mangrove stems decrease drastically (Méndez-Alonzo et al., 2006) despite an increase in the size and biomass of dry leaves due to increasing latitude.

Due to the trees' huge size and need for a lot of space to grow and develop, trees that are not adjacent to one another should be spaced out by 7-8 meters. The mangrove canopy is impacted because the meeting points between the branches are far apart due to the large spaces between individuals caused by the size of the large trees and the distances between the trees. The number of leaves on the *Sonneratia alba* species growing at this station visually indicates the age of the old tree. The findings of the study were also previously published in North Maluku and Indonesia, such as Nurdiansah and Dharmawan's (2017) reported that on Tidore Island and its surrounds, which revealed a medium-high canopy cover value (61-78%) as a consequence of the research. Baksir et al. (2018) on the coast of Minaluli village, North Maluku, discovered a medium-high proportion of mangrove canopy cover (72-82%). Faizal et al. (2023) reported that the canopy cover in Makassar City ranges from 84.36 to 91.89% (dense category). In the Demak Coast, Purnama et al. (2020) discovered 81% canopy cover. In the East Bolaang Mongondow shore, Patty et al. (2022) reported that a moderate to canopy coverage of mangrove (60-80%). The presence of mangroves is supported by the bioecology, and the area has mature mangroves that are able to grow well, according to the high value of canopy closure (Baksir et al., 2018; Pribadi et al., 2020).

Each station's mangrove density was observed to vary (Figure 3). According to the Decree of the Minister of Environment No. 201 of 2004 the overall density of mangroves is considered low (sparse) (Table 2). Yet, due to its potential to undermine mangroves' ability to survive, this practice cannot be permitted over an extended period of time. Generally speaking, based on morphological traits, it can be deduced that the *S. alba* mangrove trees in this location have been growing and developing for a long time; hence, it can be concluded that the tree is old but has a small trunk diameter. Minor groupings of species, *R. mucronata* and *R. apiculata*, do not establish communities. These two species are discovered to be dispersed and challenging to group together. Large populations of the dominant group (*Sonneratia alba*) grow and develop, with a range of morphological sizes (medium and big), expanding distances, and varying cover. It may require a complete biological analysis, as well as extensive research on ecological issues. Environmental factors in the area are said to

influence growth. The study's findings are comparable to those from Kutai National Park (KNP). Mangrove density was found to be in the low-medium range in East Kalimantan, another Indonesian equatorial region (700–1200 trees/ha) (Poedjarahajoe et al., 2019). The amount of mangroves depends on the number of people present and the local community's activities (Buwono, 2017; Akbar et al., 2019). Due to logging of mangroves and sand mining, there are less mangroves per square mile (Masiyah and Sunarni, 2015). Due to the unpredictable position and distance of growth, the natural development process can also affect the density of mangrove trees. According to Muhtadi et al. (2020), the diameter of the tree trunks had an impact on Sambilan Island's high density, which did not result in a high land cover.

The equator is supposed to have an impact on the growth of mangroves because its unique environmental and climatic circumstances set it apart from other places. The equator is where mangrove growth reaches its highest biomass (Kuenzer et al., 2011). With increasing latitude comes a decline in light intensity, humidity, and ambient temperature, which affects the quantity and quality of fruit (Hong et al., 2021). According to morphological size, the equator can cause significant differences. For instance, in the *Avecenia marina*, it was discovered that there were different heights by region, including West Kalimantan and Marauke (20 meters) (Dharmawan et al., 2020), but in Qatar, the height of *Avecenia marina* was only 3 meters (Al-Khayat JA and Alatalo JM, 2021), and Futian, China and Auckland, New Zealand have (Tam et al., 1995; Ravi, 2019). All indicators point to the presence of mangroves along Tawabi Island's coast (Table 4). In a stable aquatic environment, mangroves can grow and thrive, and there is no evidence of environmental deterioration or changes in extreme water indicators. Mangroves and marine biota typically have tolerance limitations for water quality concentrations (Schaduw et al., 2018; Syahril et al., 2020). Vertical temperature distribution is found in latitude of Indonesia (the Halmahera Sea) 27°C at the surface and 7°C at a depth of 550 meters and surface salinity 34‰ and 35‰ at a depth of 650 meters (Purba et al. 2021). The research results have characterized the chemical and physical characteristics of the sea at the equatorial latitude of Tawabi Island. Kayoa.

Mangrove zoning is a term used to describe how mangrove bodies are arranged and distributed from the sea to the land under the influence of the sea tides (Koroy et al., 2020). The front zone (sea), where *S. Alba* is the dominant species. The bulk of the *S. Alba*

species are found in the back zone, whereas the middle zone is mixed (*S. Alba*, *R. apiculata* and *R. mucronata*). According to Noor et al. (2012) the mangrove zone is typically separated into three zones: the center zone, the brackish to fresh zone, and the landward zone (affected by fresh water). Mughofar et al. (2018) at Cengkong Beach, Karanggandu Village, Trenggalek Regency, East Java Province, Windah (2018) in the former tsunami mangrove area in South West Aceh, and Upara et al. (2021) also reported research findings on the coast of Darunu Village, Wori District, North Minahasa Regency which identified *Sonneratia* as a superior zone species on the coast.

Research in several Indonesian regions has also revealed variations in frontal zoning, with findings showing *Rhizophora* spp. is the primary component of the frontal zoning of mangroves (Bunt, 1996; Gunarto, 2004; Tarigan, 2008; Darmadi, 2012; Akbat et al., 2017a). In general, it has been noted that *Avecenia* species, which have been reported, make up the majority of the mangrove arrangement in the front region (White, 1989; Macnae, 1966, 1968; Chapman, 1976, 1992; Nybakken, 1993; Sulong et al., 2002; Putri et al., 2015; Koroy et al., 2020; Rahmadhani et al., 2021). Environmental dynamics, including oceanic elements (tides, waves, and currents), biological factors (progle maturity, genetics, reproduction, and physiology), and ecological considerations, all play a role in the process of zoning (substrate, salinity, pH, DO, phosphate, nitrate).

Each mangrove on Tawabi Island contributes biologically to the process of upkeep and community maintenance. In Tawabi Island, mangrove species have developed distinct physical and genetic traits as a result of long-term environmental (adaptation). In the Tawabi Island coast, a homogeneous substrate type is the primary and final constituent, *S. Alba*. The medium-density sand substrate is uniformly spread out horizontally and enlarges toward the ocean. The results of field observations found that seagrass area is within the mangrove front zone, and the reef slope has a range (100-150 meters). Since the beach's topography slopes (100-150 meters) towards the water and has the same kind of substrate (medium sand), coastal ecosystems can exist there (mangrove, seagrass and coral reefs).

The Sidangoli coast has mangrove thickness ranging from 145 to 750 meters, according to research on differences in mangrove thickness by Akbar et al. (2015). In Dodinga Bay in West Halmahera, mangrove thickness was measured to be between 60 and 130 meters by Akbar et al. (2017b)

and between 85 and 150 meters by Akbar et al. (2016) on Mare Island. Tidal effects, mangrove distribution, station sites, and coastal topography all play a role in the variation in mangrove thickness.

Conclusion

Three different varieties of mangroves can be found on Tawabi Island (*R. apiculata*, *R. mucronata* and *S. alba*). The mangroves' canopy cover is a useful category for describing their health (a good category). Because some species predominate in the area, mangrove density falls into the category of medium. The dominance species (*S. alba*) is a large, tall tree, thus it needs room to spread out and develop. The environment sea is suitable for the growth of mangroves. The front and back zones are made up entirely of *S. alba*, whereas the intermediate zone is a thin mixture of *R. apiculata*, *R. mucronata* and *S. alba*. Tawabi Island exhibits originality and the most recent information overall as an aquator island. we suggest that a complete ecosystem profile of Tawabi Island needs to be fully described, so that extensive investigations should be carried out in the future.

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