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DISTRIBUTION OF MANGROVE PROPAGULES *RHIZOPHORACCEAE* IN THE DAMBALO COASTAL AREA TOMILITO DISTRICT NORTH GORONTALO REGENCY

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Abstrak

Mangroves as one of the coastal natural resources that can be recovered are tropical coastal vegetation communities, which are dominated by several species of mangrove trees that can grow and develop in muddy coastal tidal areas. The growth development of mangrove propagules, especially the seedling level, is strongly influenced by several factors such as; salinity, water temperature, tidal currents, tidal height, substrate, waves/tidal waves, water turbidity, sunlight, slope of the location, and so on. The purpose of this research is to determine the distribution pattern of Propagul mangrove rhizophoracceae found in the coastal area of Dambalo Village, Tomilito District, North Gorontalo Regency, Gorontalo Province. The method used is simple random sampling. There are three types of mangrove Rhizophorasp in the coastal area of Dambalo village, namely Rhizoporaapiculata, Rhizoporamucronata, and Rhizoporastylosa. In addition, there are two types of distribution patterns, namely uniform patterns and clustered patterns. The uniform pattern is found in Rhizophoramocronata and Rhizophorastylosa, the group distribution pattern is found in Rhizophoraapiculata.

INTRODUCTION

Mangroves are one of the most widely reclaimed coastal resources as coastal vegetation communities. Many mangrove tree species are able to grow and thrive in muddy coastal areas. Most of these plant communities grow in seasonal areas and along oceans with high water flow and are protected from large waves and strong tidal currents (Ernikawati et al., 2023). This is because mangrove forests can be found in shallow bays, river estuaries, valleys, ravines, small islands, and sheltered coastal areas. The word "mangrove" is a combination of the words "mangrove" (Portuguese), meaning plant, and "forest" (English), meaning forest or small forest. Mangroves are plants that form small forests (Ruruh & Ernikawati, 2021).

The benefits of mangrove ecosystems in relation to physical activity include reducing hazards such as waves and storm surges in the surrounding area, protecting the coast from hurricanes, tidal waves (breaking water), and tsunamis, retaining silt and trapping sediment carried by surface water, preventing the influx of seawater into land, and eliminating water pollution to a certain extent (Ruruh, 2025).

Mangrove vegetation growth, particularly vegetation cover, is significantly influenced by several factors, including salinity, water temperature, tides, sea level, substrate, waves/tides, water temperature, sunlight, sea level rise, and others (Ruruh & Suma, 2024). Distribution patterns are a characteristic of each organism in a village. These patterns depend on the environmental and biological characteristics of the organism itself. Organisms within a population can be distributed in three broad forms: random distribution, uniform distribution, and clumped distribution (Ruruh, 2025).

LITERATURE REVIEW

Mangroves are forests that grow and thrive in coastal areas frequently affected by tides. To maintain biological balance in waters, forests that thrive in unique environmental conditions and possess various advantages and interconnections are crucial for the life of both vegetation and wildlife(Sulaminingih et al., 2024). Located at sea level, where tides are high, these plants collectively form forests that are frequently affected by tides, with their roots extending upwards, distinguishing them from other upland forests. Mangroves are unique coastal environments, with their roots, fruits, and habitats, as well as their role as a barrier against disasters such as tsunamis, sea breezes, abrasion, and habitat for living organisms (Ruruh & Ernikawati, 2021).

Mangrove ecosystems thrive in tidal zones along tropical coastlines, such as lagoons, swamps, deltas, and river estuaries. Mangrove ecosystems are complex and dynamic, yet unstable. Complex because the mangrove ecosystem, the waters, and the soil beneath it provide habitat for various species of terrestrial and aquatic life (Ruruh et al., 2024). Dynamic because the mangrove ecosystem can continue to grow and develop, experiencing succession and zoning changes depending on its location. Unstable because it is easily damaged and difficult to recover. Mangrove growth will decline if the supply of freshwater and sediment is low (Puspaningrum et al., 2024).

Rhizophoraceae; *Bruguiera cylindrica, B. sexangula, B. parviflora, B. gymnorrhiza, Ceriops decandra, C. tagal, Rhizophora apiculata, R. stylose, R. mucronata.* General Description: Compared to other species, species from this family are more prevalent and easily found. This is because they are easy to grow and propagate. Species from this family are known by various names: Bako/mangrove, Bako minyak, Bako kurap, Tengar, and others. The easiest way to identify them is by

the shape of their prop roots (*Rhizophora* spp.) and knee roots (*Bruguiera* spp.), as well as the unique, long, stick-like shape of their fruit (Ruruh et al. 2026). This species is dominant in mangrove forests, forming large communities (clusters) and is tolerant of direct sunlight. It grows normally in the deepest flooded areas and in humus-rich soil (Ruruh et al., 2026).

Planting Techniques, Direct Method: Plant seeds (propagules) directly on the site. Propagule such as *Rhizophora* spp. should be planted into muddy soil at a depth of 10–15 cm for stability. Mangrove Seedlings: Plant seedlings after sowing in the nursery to ensure root strength (Ruruh, Haris, et al., 2025). Plant seedlings in the prepared site, spacing them approximately 1.5 meters apart to prevent competition. Fencing and Supports: Install supports (such as bamboo or wooden poles) to protect seedlings from strong currents and waves. Use fencing to prevent disturbance from animals such as crabs or livestock. Cluster Technique: Plant seedlings in groups in a circular pattern to accelerate sediment binding and encourage ecosystem development (Ruruh, 2025).

METHOD

1. ***Time and Place.***

   The observations were conducted over a two-month period, from December 2025 to January 2026, in the coastal area of Dambalo Village, Tomilito District, North Gorontalo Regency, Gorontalo Province.

2. ***Tools and Materials***

   The tools used in the observations included a GPS, measuring tape, camera, and laptop. The materials used were rapia string, tally sheets, and writing utensils.

3. ***Data Types and Sources***

   The types and sources of data used were: 1) Primary data, which was obtained directly through field observations around the coastal area of Dambalo Village, Tomilito District, North Gorontalo Regency, Gorontalo Province. 2) Secondary data, which was obtained through literature studies, such as journals and previous research.

4. ***Population and Sample***

   The population and sample used were: 1) The population for the observations was the entire mangrove forest area in the coastal area of Dambalo Village, Tomilito District, North Gorontalo Regency, Gorontalo Province. 2) The sample in the observation was a 10m x 10m plot in observing the distribution pattern of mangrove propagules in Dambalo Village, Tomilito District, North Gorontalo Regency, Gorontalo Province.

5. ***Data Collection Techniques***

   The method used was simple random sampling. The steps in forming a sample collection plot were: 1) Establish a single sampling point for a sampling station in a different area (through other groups). 2) Establish a monitoring station, designate a monitoring plot measuring 2m x 2m. 3) Collect data on the number of mangrove individuals within each plot. 4) The data parameters collected were mangrove species and the number of individuals of each species (seedlings).

6. ***Data Analysis***

   The collected data were then analyzed using the Morosita distribution index formula (Ruruh & Suma ZNY, 2024). The analysis of distribution patterns for each species used the following research index:

$$Id = \frac{n\sum x^2 - N}{N(N-1)}$$

The description :

Id = Distribution index
n = Number of plots
N = Total number of individuals in a plot
$\sum x^2$ = Squared number of individuals in a plot

RESULTS AND DISCUSSION

The mangrove forest in Dambalo Village, Tomilito District, North Gorontalo Regency, covers approximately 233 hectares and is spread across three of the five hamlets: Hukolo, Tengah, and Simpang Tiga. The mangrove ecosystem is a coastal natural resource that plays a vital role in socio-cultural, economic, and ecological aspects (Ruruh & Ernikawati, 2021).

Observations in Dambalo Village, Tomilito District, North Gorontalo Regency, Gorontalo Province, revealed three species of Rhizophora sp. (*Rhizophora apiculata*, *Rhizophora mocronata*, and *Rhizophora stylosa*). A total of 493 individuals of these three species were identified in 30 plots measuring 10 m x 10 m, as shown in the following table:

Table 1. Sampling Results

NO	Types Of Mangroves	Number of individuals (N)
1	*Rhizophora apiculata (Wu'ata Buyuhu)*	245
2	*Rhizophora mocronata (Wu'ata Putih)*	128
3	*Rhizophora stylosa (Wu'ata Biasa)*	120
	Amount	493

The data above shows that *Rhizopora apiculata* dominates the area with the highest distribution, with 245 species across all plots. The second highest distribution is Rhizophora mocronata, with 128 species, and the lowest distribution is Rhizophora stylosa, with 120 species.

Rhizopora apiculata dominates the area because it thrives in muddy, smooth soil that is inundated by normal tides. According to (Ruruh et al, 2025), *Rhizophora apiculata* can grow in well-drained soil that is inundated by normal tides. *Rhizophora apiculata* is one of the most popular plant species in any region or region. *Rhizophora apiculata* is a tree that can grow up to 30 cm tall and up to 50 cm in diameter.

Unlike *Rhizophora apiculata*, which dominates Dambalo Village, *Rhizophora stylosa* has the lowest distribution in Dambalo Village. According to (Ruruh et al., 2026), the most typical habitats and locations for *Rhizophora stylosa* are found on mangrove edges near islands and coral substrates. *Rhizophora stylosa* has the lowest values because this species prefers muddy, rocky, and sandy habitats.

In data collection, the first step is to determine the location of the plot to be observed. The second step is to create the first trap measuring 10 m x 10 m, which is placed in an area (carefully considered) that represents all different species. After creating the first column, additional markers are made for all seedling-stage species. The third step is to create subsequent plots at intervals of approximately ±50 m.

The research revealed three types of *Rhizophora* sp. mangroves. These three types can be distinguished using the following criteria:

1. ***Rhizophora apiculata***

   The leaves are dark green, light green in the center, and red below. The stalk is 17-35 mm long and red. It is narrowly elliptical with a curved tip. The fruit is elongated, like a brown pear, 2-3.5 cm long, containing one seed. It has a ring/hypocotyl measuring 18-38 cm long and 1-2 cm in diameter.

2. ***Rhizophora mocronata***

   It has green stems measuring 2.5-5.5 cm long. The leaves are pinnate at the base, 5.5-8.5 cm in diameter, rounded with elongated whorls and ribbon-like tips, measuring 11-23 cm x 5-13 cm. The egg is oblong to egg-shaped, 5-7 cm long, and the propagules/hypocotyls are 36-70 cm long and 2-3 cm in diameter.

3. ***Rhizophora stylosa***

   It has green leaf stalks 1-3.5 cm long and pine needles 4-6 cm long, with a wide cylindrical shape and ribbon-like edges. The pears are 2.5-4 cm long, with brown fruit 2.5-4 cm long. The propagules/hypocotyls measure 20-34 cm (sometimes up to 50 cm) and have a diameter of 1.5 to 2.0 cm.

The distribution pattern can be determined by summing the Morosita exponential values, resulting in the following conclusions:

id = 1: Random distribution pattern
id > 1: Group distribution pattern
id < 1: Uniform distribution pattern

Observations in the coastal area of Dambalo Village, Tomilito District, North Gorontalo Regency, Gorontalo Province. There were three *Rhizophora* sp. species at three stations, each with 10 measurement points. This can be seen in the following table:

Table 2. Results of Propagule Distribution Measurements

Station 1 (Measuring Plot 1 -10)					
No	Type name	n	N	$\sum x^2$	id
1	*Rhizophora apiculata*	10	168	87	2,6
2	*Rhizophora mocronata*	10	168	43	0,5
3	*Rhizophora stylosa*	10	168	38	0,4
Average dispersion index at the station 1					3,23
Station 2 (Measuring Plot 11 -20)					
No	Type name	n	N	$\sum x^2$	id
1	*Rhizophora apiculata*	10	152	72	2,1
2	*Rhizophora mocronata*	10	152	43	0,7
3	*Rhizophora stylosa*	10	152	37	0,5
Average dispersion index at the station 2					2,97

Station 3 (Measuring Plot 21 -30)					
No	Type name	n	N	$\sum x^2$	id
1	*Rhizophora apiculata*	10	173	86	2,4
2	*Rhizophora mocronata*	10	173	42	0,5
3	*Rhizophora stylosa*	10	173	45	0,6
Average dispersion index at the station 3					3,10

From Table 2 at Station 1, it is known that *Rhizophora apiculata* has the highest distribution index value of 2.6, with a distribution pattern >1, indicating a group distribution pattern. *Rhizopora mocronata* has a distribution index value of 0.5, with a distribution pattern <1, indicating a uniform distribution pattern. The lowest distribution index value, at 0.4, is *Rhizophora stylosa*, with a distribution pattern <1, indicating a uniform distribution pattern. The average distribution index value at Station 1 is 3.23.

From Table 2 at Station 2, it is known that *Rhizophora apiculata* has the highest distribution index value of 2.1, with a distribution pattern >1, indicating a group distribution pattern. *Rhizopora mocronata* has a distribution index value of 0.5, with a distribution pattern <1, indicating a uniform distribution pattern. The lowest distribution index value, at 0.5, is *Rhizophora stylosa*, with a distribution pattern <1, indicating a uniform distribution pattern. The average distribution index value at Station 2 is 2.97.

From Table 2 Station 3, it is known that the *Rhizophora apiculata* species has the highest distribution index value of 2.4 with a distribution pattern > 1, meaning a group distribution pattern. *Rhizopora stylosa* has a distribution index value of 0.6 with a distribution pattern < 1, meaning a uniform distribution pattern. And the lowest distribution index value with a value of 0.5 is *Rhizophora mocronata* with a distribution pattern < 1, meaning a uniform distribution pattern. The average distribution index value at station 3 is 3.10.

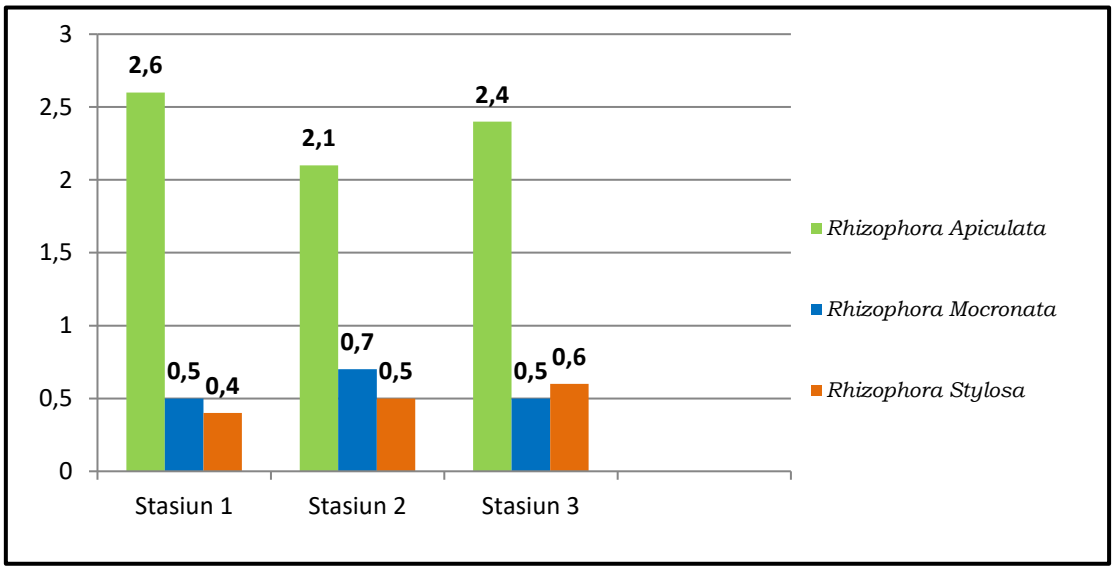

Figure 1. Diagram of Propagule Distribution Pattern

From the three observation stations above, two types of distribution patterns were observed: a group distribution pattern and a uniform distribution pattern. Two of the three *Rhizophora* species, *Rhizophora mocronata* and *Rhizophora stylosa*, exhibited a uniform distribution pattern, while Rhizopora apiculata exhibited a group distribution pattern.

The group distribution pattern is a pattern that occurs in the environment. Furthermore, (Ernikawati et al., 2023) argue that group distribution within a population is a common distribution pattern in the environment, for both plants and animals. According to a study conducted in Dambalo Village, the three observation stations found the Rhizopora apiculata plant species exhibited a group distribution pattern. Furthermore, as explained (Ruruh et al., 2025), the structure of the group distribution pattern depends on the feeding pattern or pathway, and the species is reserved for areas with abundant food sources.

At the study site, two *Rhizophora* species were found to have a uniform distribution pattern: *Rhizophora mocronata* and *Rhizophora stylosa*. Of the three safety stations, these two species exhibit similar distribution patterns. According to , their distribution is similar to that of plants. This type of scattering occurs when there is intense competition between individuals within a population, such as for nutrients and space. Ruruh et al. (2026) also argue that similar distributions reflect negative interactions between individuals, such as competition for nutrients and sunlight.

CONCLUSION

In the observation in Dambalo Village, Tomilito District, North Gorontalo Regency, it can be concluded as follows: There are three types of *Rhizophora* sp mangroves in the coastal area of Dambalo Village, namely *Rhizophora apichulata*, *Rhizophora mocronata*, and *Rhizophora stylosa*. There are two types of distribution patterns, namely uniform patterns and grouped patterns. Uniform patterns are found in *Rhizophora mocronata* and *Rhizophora stylosa*, group distribution patterns are found in *Rhizophora apiculata*.

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