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Identification of Coastal Mangroves in the Legend Ecotourism Pademawu District Pamekasan Regency: an Explorative Descriptive Study

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Abstract

Mangrove inventory is important for monitoring and supporting building mangrove management strategies in the future. Until now, there has been no data collection on what types of mangroves grow in the coastal area of The Legend Pademawu. This study aims to record what types of mangroves exist in the area. Data on mangrove species were collected using exploratory descriptive methods. The results showed that mangroves found in the coastal area of The Legend Padelegans Village, Pademawu District, Pamekasan Regency amounted to 11 species grouped into 7 families. Most mangrove species are dominated by the Rhizoporaceae family which amounts to 3 species. Following up on the findings in this study, in the future it is necessary to carry out mangrove ventilation for monitoring and supporting in building mangrove management strategies in the future.

Introduction

Geographically, Indonesia is the largest archipelagic country in the world. Based on PUPR Infrastructure Statistics Information (2021), the area of the State of Indonesia reaches 1,916,906.77 km^2. With this area, Indonesia consists of many islands. According to Sukardiyono & Rosana (2019), the number of islands in Indonesia is 17,000 islands. In addition, Fau (2020) states that the length of the coastline in Indonesia reaches 95,181 km. These geographical conditions make Indonesia a mega-biodiversity country with the second highest level of diversity in the world (Fau, 2020; Sukardiyono & Rosana, 2019; Wasis et al., 2019). Biodiversity in Indonesia includes gene-level diversity; species-level diversity which includes the diversity of plants, animals, microorganisms, and so on; and ecosystem-level diversity which includes terrestrial ecosystems and aquatic ecosystems (Fau, 2020).

Aquatic ecosystems store a lot of diversity, one of which is the coast. Similarly, The Legend coastline is located in Padelegans Village, Pademawu District, Pamekasan Regency. Pademawu District is a coastal area in the southern part of Madura Island. The coastal area of Pademawu is generally dominated by muddy beaches and some sandy beaches (Mahabror, 2021). The length of the coastline in Pademawu District is 19 km (Ismail et al., 2022).

Based on an ecological point of view, coastal ecosystems are important areas (Amin & Purnomo, 2021). In a coastal ecosystem, there is an exchange of matter and energy transformation between components in the system itself and with other system components outside it (Baderan et al., 2021). Coastal areas are still directly influenced by human activities and natural phenomena such as tides, sedimentation,

and freshwater flows (Lautetu et al., 2019). Coastal areas are very vulnerable to environmental pressures both from land and from the sea (Prayogi et al., 2021).

Coastal areas need an ecological balancer such as mangrove forests. Mangrove forests on the coast act as an ecological balancer that can protect coastal areas from natural disasters such as tsunamis and other natural disasters (Syahrial et al., 2020). In addition, mangrove forests can maintain a stable coastline and protect the coast from seawater abrasion, as well as act as a nursery ground, feeding ground, and spawning ground for marine life (Sipahelut et al., 2020).

The largest mangrove ecosystem in the world is in Indonesia, which is around 26-29% of the world's mangrove ecosystem in Indonesia (Soeprobowati et al., 2022). So far, in Indonesia, there are at least 202 species of mangrove plants, which include 1 type of fern, 44 types of epiphytes, 44 types of soil herbs, 19 types of lianas, 5 types of palms, and 89 species of trees. Of the 202 species, 43 species (including 33 species of trees and several types of shrubs) were found as true mangroves, while other types were found around mangroves and known as associate mangrove types (Syakur, 2019). The diversity of mangroves can be influenced by environmental factors (Rahmasari et al., 2019). Such as salinity, soil type, inundation by tides, and wave exposure. Facing variations in environmental conditions like this, mangrove vegetation zoning will naturally form (Tefarani et al., 2019).

One of the contributors to the percentage of mangrove ecosystems in the world is The Legend Pademawu Beach. But until now there has been no data collection on what types of mangroves grow in the area. So researchers are interested in conducting mangrove inventory research so that the types of mangroves on The Legend Pademawu beach are identified. Until now, it is estimated that all mangrove species in Indonesia have been collected but fundamental weaknesses occur in the process of identifying and publishing specimen collection results (Djamaluddin, 2018). The identification process which is carried out by observing and comparing the morphology of mangrove plants, requires precision. This is caused by researchers who are often confused by the morphological characteristics of mangrove species, which are almost the same but are actually different species. However, this research is not to find a solution for a more accurate and efficient method of identifying mangrove species. This research is only limited to identifying mangrove species that inhabit The Legend ecotourism area, where until now there has never been any research regarding the identification of mangrove species that inhabit in there. So it is hoped that this research data can help the authorities when they collect data on mangrove species in the The Legend ecotourism area in the future. And publish the data. In addition, according to Rahadian et al. (2019), research on mangrove inventory is important to be carried out considering the diversity of mangrove area data is a national problem, namely about the existence and distribution of reliable and consistent mangrove forests. Mangrove inventory is important for monitoring and supporting building mangrove management strategies in the future.

Methods

This research is exploratory descriptive research with a qualitative approach. Exploratory researchis a method of direct observation at the place of research. In addition, this research also includes descriptive research, because the data to be collected is in the form of words and images, not emphasizing numbers, but more emphasis on processes than products (Sugiyono, 2017). The tools and materials used in this study are camera for documentation; a mangrove identification book Djamaluddin (2018); Muzaki et al. (2012); Muzaki et al. (2019); Noor et al. (2007); & Sidik et al. (2018); Stationery; roll meter; scissors; Cutter; plastic; and label paper. While the material used in this study is mangrove plants in the coastal area of The Legend Pademawu.

The sample return was carried out at The Legend Coast of Padelegans Village, Pademawu District, Pamekasan Regency in February 2023 with 6 samplings. Figure 1 is a map of the Legend ecotourism beach. Symbols 1, 2, 3 on the map are the locations that used as sampling locations by researchers. This study began by determining the sampling station using the Purposive Sampling method. Followed by sampling at the research site. Samples were taken in the form of flowers, fruits, and leaves and noticed and recorded morphological characteristics of stems and roots. At the same time take pictures of each part of the mangrove plant's roots, stems, leaves, fruits, and flowers, as well as taking pictures of mangrove trees as a whole. Identification is carried out by comparing samples from observations guided by the Mangrove Identification book. In addition, sample identification also uses the Plant Net and Google Lens applications. Then the collected data is analyzed descriptively, tabulated, and presented in the form of tables and figures.

Figure 1. Sampling location for mangrove species at The Legend ecotourism beach

Results and Discussion

The results showed that mangroves found in the coastal area of The Legend Padelegans Village, Pademawu District, Pamekasan Regency amounted to 11 species grouped into 7 families. These species can be seen in Table 1.

Table 1. Types of mangroves on the coast of The Legend

No	Family	Species
1	Myrsinaceae	*Aegiceras corniculatum*
2	Avicenniaceae	*Avicennia officinalis*
3	Avicenniaceae	*Avicennia marina*
4	Verbenaceae	*Clerodendrum inerme*
5	Convolvulaceae	*Ipomoea pes-caprae*
6	Combretaceae	*Lumnitzera racemosa*
7	Rhizoporaceae	*Bruguiera gymnorrhiza*
8	Rhizoporaceae	*Rhizopora apiculata*
9	Rhizoporaceae	*Rhizophora mucronata*
10	Aizoaceae	*Sesuvium portulacastrum*
11	Sonneratiaceae	*Sonneratia alba*

Table 1 shows that most mangrove species are dominated by the Rhizoporaceae family which amounts to 3 species. Then from the family Avicenniaceae which numbered 2 species. In addition, mangrove species from the families Myrsinaceae, Verbenaceae, Convolvulaceae, Combretaceae, Aizoaceae, and Sonneratiaceae were also found 1 species each. Mangroves found at the study site consist of true mangroves and associated mangroves.

True mangroves are plants that form morphological specialties such as aerial roots and other special physiological mechanisms to excrete salt to adapt to the mangrove environment. Association mangroves are groups that never grow in true mangrove communities and usually live with land plants (Sidik et al., 2018).

Description of the types of mangroves found

Aegiceras corniculatum

Aegiceras corniculatum is a type of mangrove in the form of shrubs or trees. It has roots creeping on the surface of the soil. The stem surface of *Aegiceras corniculatum* is gray to reddish-brown. Leaves are oval or elliptical in shape. The lower part of the leaf is pale green and the top of the leaf is dark green. Flowers are arranged in bunches, corolla of flowers is 5 in number, white in color covered with fluffy short hairs. Fruits are green to reddish when ripe, have smooth surfaces, and are bent like sickles (Noor et al., 2007). Respectively, figures 2 a, b, c, d, and e are pictures of roots, stems, leaves, flowers, and fruit of the mangrove species *Aegiceras corniculatum.*

The ecology of *Aegiceras corniculatum* has a high tolerance to salinity, soil, and diverse light (Muzaki et al., 2012). Generally grows in areas that are flooded by normal tides and the edges of seasonally flooded waterways (Muzaki et al., 2019). *Aegiceras corniculatum* is distributed in Sri Lanka, Malaysia, Indonesia, Papua New Guinea, southern China, Australia, and the Solomon Islands (Noor et al., 2007).

a)  b)  c)  d)  e) 

Figure 2. *Aegiceras corniculatum*, a) roots; b) rods; c) leaves; d) flower; e) fruit

Avicennia officinalis

Avicennia officinalis has a habitus of shrubs or trees. Around the base of the stem are often found aerial roots. The surface of the stem is reddish-brown and smooth. Leaves are ovate to elliptical with rounded leaf tips. The upper surface of the leaves is green while the lower surface is paler. The corolla of flowers is 4 in number, yellow or orange. Petals of flowers number 5. Stamens are 4 in number, longer than the crown leaves. Fruits are shaped like hearts, the tip has a short beak, the color is greenish-yellow. The surface of the fruit is densely covered with short fine hairs and slightly wrinkled (Muzaki et al., 2012). Respectively, pictures 2 a, b, c, d, and e are pictures of roots, stems, leaves, flowers, and fruit of the mangrove species *Avicennia officinalis*.

Generally the ecology of *Avicennia officinalis* grows on along river boundaries that are still affected by tides or on the edge of mangrove swamps. This plant is one of the most common types of mangroves (Muzaki et al., 2012). *Avicennia officinalis* distributate in Indonesia, southern India, Malaysia, and eastern Australia (Noor et al., 2007).

a)  b)  c)  d)  e) 

Figure 3. *Avicennia officinalis*, a) roots; b) rods; c) leaves; d) flower; e) fruit

Avicennia marina

Avicennia marina is a mangrove in the type of shrubs or trees. It has a breath root with a horizontal root system that is pencil-shaped (or asparagus-shaped). The bark of the trunk is green to gray, finely textured, and exfoliates in small parts. Leaves elliptical, elongated rounded, inverted ovate with a tapered tip to a rounded end. The bottom of the leaves is paler and the top is green. Flowers are collected at the ends of flower stalks. The corolla of flowers is 4 strands of yellow or orange color. Petals of flowers number 5 strands. Fruits are slightly rounded, grayish-green in color. The tip of the fruit is rather sharp like a beak and The surface is smooth-haired (like there is flour) (Muzaki et al., 2019). Respectively, pictures 2 a, b, c, d, and e are pictures of roots, stems, leaves, flowers, and fruit of the mangrove species *Avicennia marina*.

Avicennia marina is a pioneer plant on protected coastal land. Besides that it can occupy and grow in various tidal habitats, even in salty places. This type of mangrove is distributed in Africa, Polynesia, Asia, Australia, and New Zealand South America. Found throughout Indonesia (Noor et al., 2007).

a)  b)  c)  d)  e)

Figure 4. *Avicennia marina*, a) roots; b) rods; c) leaves; d) flower; e) fruit

Clerodendrum inerme

Clerodendrum inerme is a type of mangrove in the form of a shrub that spreads and expands on the ground surface. Dark green leaves are glossy at the top, stiff, and bent inward. At the time of sampling, this type of mangrove was not flowering. Based on information obtained from the book by Noor et al. (2007),*Clerodendrum inerme* flowers are, bell-shaped. Located in the armpits of leaves with clustered formations (3 flowers per group). The corolla of flowers is 5 strands in number, pure white, the bottom is long-stemmed. Petals of flowers are green and some distance from the leaves of the corolla. While the stamens are very long when compared to the corolla, they are purplish red (Noor et al., 2007). Fruits are ovoid, green-brown in color (Noor et al., 2007). Respectively, pictures 2 a, b, c, d, and e are pictures of roots, stems, leaves, flowers, and fruit of the mangrove species *Clerodendrum inerme*.

The ecology of this plant usually grows on muddy or sandy substrates behind mangrove forests or

around brackish waters (Muzaki et al., 2012). The distribution of *Clerodendrum inerme* is likely to spread throughout Indonesia. At least recorded in Java and Bali (Noor et al., 2007).

a)  b)  c)  d)  e) 

Figure 5. *Clerodendrum inerme*, a) roots; b) rods; c) leaves; d) flower; e) fruit

Ipomoea pes-caprae

Ipomoea pes-caprae is a thick-rooted herb whose roots grow on the internodes of the stem. The stem is creeping, spherical in shape, wet, and brownish-green in color. The leaves are thick and shiny, ovoid-like horseshoes. Flowers are trumpet-shaped, pink - purple and slightly dark at the base of the flower. The flowers fully open before noon, then close afternoon. Fruits are round or slightly flattened and downy (Muzaki et al., 2012). Respectively, pictures 2 a, b, c, d, and e are pictures of roots, stems, leaves, flowers, and fruit of the mangrove species *Ipomoea pes-caprae*.

Ipomoea pes-caprae can grow in coastal areas up to an altitude of 600 meters above sea level. It often grows to form its zone (pes-caprae zone) in front of the coastal forest. Spread throughout the coastal areas of East Java, it grows very well in areas with sand substrates (Muzaki et al., 2019).

a)  b)  c)  d)  e) 

Figure 6. *Ipomoea pes-caprae*, a) roots; b) rods; c) leaves; d) flower; e) fruit

Lumnitzera racemosa

Lumnitzera racemosa is a type of mangrove in the form of shrubs or small trees and has no breath roots. The bark of the trunk of *Lumnitzera racemosa* is reddish-brown and has longitudinal cracks, especially on old stems. Leaves stiff, rather thick fleshy, narrowed oval shape with rounded tips, clustered at the ends of twigs. Flowers are unstemmed, and corolla leaves numbering 5 strands are white. Petals of flowers number 5 strands, green in color. Fruits are elliptical, yellowish-green, fibrous, woody, and dense (Noor et al., 2007). Respectively, pictures 2 a, b, c, d, and e are pictures of roots, stems, leaves, flowers, and fruit of the mangrove species *Lumnitzera racemosa.*

It grows along the edges of mangrove vegetation and loves substrates in the form of dense mud. It can also be found along watercourses (Muzaki et al., 2012). *Lumnitzera racemosa* is distributed from tropical eastern Africa and Madagascar to Malaysia, throughout Indonesia, PNG, northern Australia, and Polynesia. It is hardly found along the coast facing the Indian Ocean (Noor et al., 2007).

a)  b)  c)  d)  e) 

Figure 7. *Lumnitzera racemosa*, a) roots; b) rods; c) leaves; d) flower; e) fruit

Bruguiera gymnorrhiza

Bruguiera gymnorrhiza is a type of mangrove in the form of trees. The root is shaped like a board extending sideways at the base of the tree and also has several knee roots. The surface of the trunk is smooth to rough textured, dark gray to brown in color. The elliptical leaves are green, the lower surface isyellowish-green. Petioles are often red. Flowers hang in the armpits of the leaves. The corolla of flowers is white, and brown when it is old. The petals of flowers are pink to red. Fruits are circular spiral, transversely rounded, blunt straight hypocotyls of green to purplish color (Noor et al., 2007). Respectively, pictures 2 a, b, c, d, and e are pictures of roots, stems, leaves, flowers, and fruit of the mangrove species *Bruguiera gymnorrhiza*.

The ecology of *Bruguiera gymnorrhiza* often grows on the back side of mangrove forests, especially in fairly dry areas with low salinity levels and moderately aerated (Muzaki et al., 2012). This type of mangrove is spread from Indonesia to the Western Pacific region and Tropical Australia and East Africa and Madagascar to Sri Lanka, Malaysia (Noor et al., 2007).

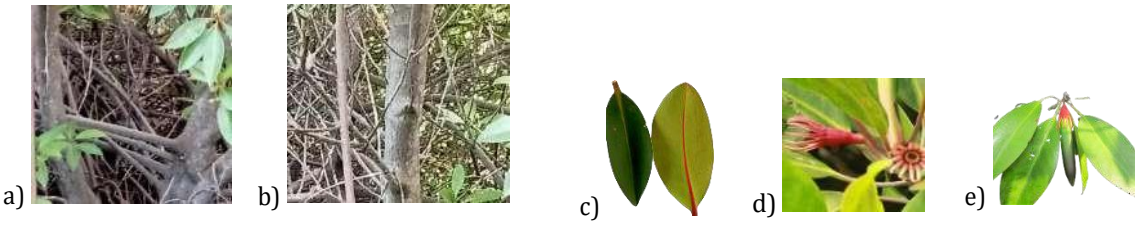

Figure 8. *Bruguiera gymnorrhiza*, a) roots; b) rods; c) leaves; d) flower; e) fruit

Rhizopora apiculata

Rhizopora apiculata is a species of mangrove in the form of trees. It has aerial roots coming out of the branches. The surface of the stem is dark gray. The leaves are elliptical in shape with a black-speckled lower surface very small, and the tips of the leaves are tapered. Petioles are often reddish in color. Flowers in pairs, corolla of 4 yellow-white flowers. Petals of flowers are 4 in number and brownish-yellow in color. The fruits are brown. The hypo-cotyledonous cylindrical is speckled, green when young, and reddish when old, about 30 cm long with a slightly rounded tip (Muzaki et al., 2019). Respectively, pictures 2 a, b, c, d, and e are pictures of roots, stems, leaves, flowers, and fruit of the mangrove species *Rhizopora apiculata*.

The ecology of *Rhizopora apiculata* grows on muddy, smooth, deep and flooded soils at normal high tide. Does not like harder substrates mixed with sand. Spread in Sri Lanka, throughout Malaysia and Indonesia to Tropical Australia and the Pacific Islands (Noor et al., 2007).

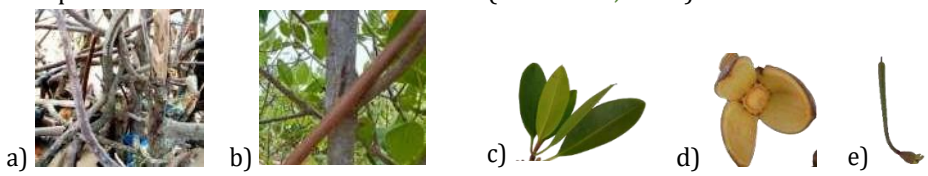

Figure 9. *Rhizopora apiculata*, a) roots; b) rods; c) leaves; d) flower; e) fruit

Rhizophora mucronata

Rhizopora mucronata or tanjang lanang is a species of mangrove in the form of trees. It has supporting roots and aerial roots that grow from the lower branching. The bark of the trunk is dark to blackish. Leaves are widened elliptical with tapered tips. The underside of the leaves is finely speckled. The corolla of 4 flowers is white and fluffy. Petals of 4 are green in number. Fruits are long oblong to ovate, hypocotyledonous cylindrical rough and nodule (Muzaki et al., 2019). Respectively, pictures 2 a, b, c, d, and e are pictures of roots, stems, leaves, flowers, and fruit of the mangrove species *Rhizopora mucronata*.

It grows on muddy or sandy and flooded substrates at normal high tide. Highly tolerant to various salinity conditions (Muzaki et al., 2019). Distributed in East Africa, Madagascar, Mauritania, southeast Asia, Malaysia, Indonesia, Melanesia, and Micronesia. Brought and planted in Hawaii (Noor et al., 2007).

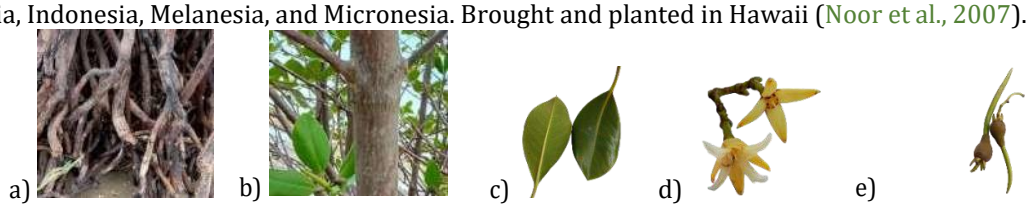

Figure 10. *Rhizopora mucronata*, a) roots; b) rods; c) leaves; d) flower; e) fruit

Sesuvium portulacastrum

Sesuvium portulacastrum is a species of mangrove in the form of creeping herbs, with reddish, smooth stems and overgrown with roots on the internodes. Leaves are small, elongated, thick, and fleshy. Flowers are small, whitish-purple in color. At the time of sampling, this type of mangrove was not bearing fruit. Based on information obtained from the book by Noor et al. (2007) Capsule-shaped, round and smooth, transverse length of approximately 8 mm. There are several black bean-shaped seeds, smooth and 1.5 mm long (Muzaki et al., 2019). Respectively, pictures 2 a, b, c, d, and e are pictures of roots, stems, leaves, flowers, and fruit of the mangrove species *Sesuvium portulacastrum*.

It often finds along the inland edges of mangroves, on mud beds and sandbars, or in areas irregularly inundated by tides. The growing substrate is sand, silt, and clay. Also found on rocky beaches, along pond ripens, and on river boundaries that are still affected by tides (Muzaki et al., 2019). Spread throughout the type of tropical beach. Found along the coasts of Java, Madura, Sulawesi, and Sumatra (Noor et al., 2007).

a)  b)  c)  d)  e) 

Figure 11. *Sesuvium portulacastrum*, a) roots; b) rods; c) leaves; d) flower; e) fruit

Sonneratia alba

Sonneratia alba is a species of mangrove in the form of trees. It has cord-shaped roots underground and comes to the surface as blunt cone-shaped breath roots. The bark of the trunk is dark white to brown.The surface of the leaves is pale green ovate, with rounded tips. The corolla of flowers is white and many anthers are white. Fruits are slightly flattened and rounded, the tips are pedunculated, and the base is wrapped in petals (Noor et al., 2007). Respectively, pictures 2 a, b, c, d, and e are pictures of roots, stems, leaves, flowers, and fruit of the mangrove species *Sonneratia alba*.

It Often finds in coastal locations that are protected from waves, this type is often found at the forefront of mangroves (Muzaki et al., 2019). Spread from North Africa and Madagascar to Southeast Asia, throughout Indonesia, Malaysia, the Philippines, Tropical Australia, the western Pacific Islands, and Southwest Oceania (Noor et al., 2007).

a)  b)  c)  d)  e) 

Figure 12. *Sonneratia alba*, a) roots; b) rods; c) leaves; d) flower; e) fruit

The results of this research are still lacking in depth, that is, the results of this research are not as detailed as the results of supporting research. It was caused by the limited data that were collected by researchers. The collected data is only limited to fulfil the identification needs of mangrove species. The researchers did not collect data on environmental factors (such as substrate, salinity and tides) that influence the number of mangrove species found at the research location. Therefore, in the future it is necessary to carry out research about what factors that influence the number of mangrove species found at The Legend Beach ecotourism for future mangrove conservation needs. Basically, research on this matter has never been carried out at that location.

Conclusions and Recommendations

Mangroves found in the coastal area of The Legend Padelegans Village, Pademawu District, Pamekasan Regency number 11 species grouped into 7 families. Most mangrove species are dominated by the Rhizoporaceae family which amounts to 3 species. Then from the family Avicenniaceae which numbered 2 species. In addition, mangrove species from the families Myrsinaceae, Verbenaceae, Convolvulaceae, Combretaceae, Aizoaceae, and Sonneratiaceae were also found 1 mangrove species each.

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