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Exploration and Identification of Banana Plant Morphology on Pagai Island, Mentawai Regency

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Abstract

Pagai Island is recognized as one of the primary centers for banana cultivation in West Sumatra. To date, the banana resources on Pagai Island have not been adequately exploited, raising concerns regarding the potential loss of germplasm if these resources are not conserved and managed effectively. The management of genetic resources can be achieved through germplasm collection via exploration activities. This study aims to provide information on the distribution and diversity of bananas on Pagai Island, located in the Mentawai Islands Regency. The research was conducted from July to November 2024. Sampling was performed using purposive sampling methods, and morphological characterization was conducted utilizing the 1996 IPGRI descriptors. The distribution of bananas is illustrated through a distribution map generated from coordinate point data using the ArcGIS 10.8 application. In contrast, the morphological characterization data is represented as a dendrogram created with the Ntsys Ver 2.02 application. The exploration yielded 22 banana accessions. Morphological characterization focused on various traits, including pseudostem tapering, anthocyanin coloration of the pseudostem, crown compactness, growth habit of the plant, petiole attitude, wing presence at the base, midrib color on the lower side of the leaf blade, leaf blade base shape, Waxiness on the lower side of the leaf blade, glossiness on the upper side of the leaf blade, and peduncle curvature. The results indicated that among the 22 banana accessions, the similarity level ranged from 42% to 100%.

Keywords: Banana, Characterization, Exploration, Germplasm, Morphology

1. Introduction

Banana (*Musa sp.*) is a significant fruit commodity with the highest production compared to other fruits in Indonesia (Dwivany et al., 2021). According to the Central Statistics Agency, banana production in 2023 reached 9.34 million tons, showing an increase of 0.97% (89.81 thousand tons) from 2022 (BPS-Statistics Indonesia, 2024). This production volume highlights bananas as the primary fruit commodity, demonstrating their superiority in Indonesia.

Bananas originating from Indonesia exhibit a high level of genetic diversity. Each region features a distinct type of banana with unique characteristics. Exploration by Suryani et al. (2023) identified 7 local Ambon banana genotypes in Rejang Lebong with varying morphological traits. Molecular characterization by Suryani et al. (2024) revealed genetic diversity among the 29 local Bengkulu banana accessions tested. Santi et al. (2022) collected data on banana germplasm in the South Buton Regency, identifying 11 banana plant cultivars with diverse morphological characteristics. Hapsari et al. (2013) also collected data on bananas in Banyuwangi, Jember, and Lumajang Regencies, each exhibiting distinct morphological traits. Dame et al. (2015) discovered 8 types of bananas in Deli Serdang Regency. Through exploration and identification, valuable information is provided to breeders to effectively utilize and manage banana germplasm, leading to the development of banana plants with enhanced performance and optimal production.

The Mentawai Islands Regency is one of the regencies in West Sumatra Province, consisting of four large islands: Siberut, Sipora, North Pagai, and South Pagai. The main livelihoods of the people in the Mentawai Islands Regency are farming and fishing. Bananas are the second most produced fruit after durian in this district. The main banana cultivation areas are located in South Pagai, North Pagai,

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and Siberut, with a total banana plantation area of 50,000 hectares. Some Mentawai population still consume bananas as their main food source (Irwandi & Erwin, 2022). According to Dame et al. (2015), fresh bananas can be consumed as a fresh fruit or processed.

Despite being a banana center in West Sumatra, the diversity of bananas in the Mentawai Islands Regency has not been managed thoughtfully, including a comprehensive exploration of the banana types in the district. This study aims to gather information about the distribution of bananas on Pagai Island, Mentawai Islands Regency, and the diversity of bananas on Pagai Island, Mentawai Islands Regency.

2. Material and Methods

This research was conducted between July and November 2024. Exploration and morphological characterization occurred in three sub-districts on Pagai Island, Mentawai Islands Regency, West Sumatra Province: Sikakap, North Pagai, and South Pagai. The tools used included a Global Positioning System (GPS), digital camera, digital meter, sack, RHS color chart, ruler, labels, and office stationery.

The survey method was employed for the exploration activity, with the selection of exploration locations determined through purposive sampling (Sugiyono, 2013) based on information provided by agricultural extension workers, community leaders, and local farmers. The distribution of banana locations is depicted on a map created using coordinate point data with the ArcGIS 10.8 application.

Morphological characterization was carried out based on IPGRI (1996), including pseudostem: tapering, pseudostem: anthocyanin coloration, plant: compactness of crown, plant: growth habit, petiole: attitude, e of wings at base, blade: color of midrib on the lower side, leaf blade: the shape of the base, leaf blade: Waxiness on the lower side, leaf blade: glossiness of upper side, and peduncle: curvature. Data from banana morphological characterization observations are presented as a dendrogram of kinship relationships (Zufahmi et al. 2019) and (Sukartini 2007) using the Ntsys Ver 2.02 application. The research stages are presented in the following diagram:

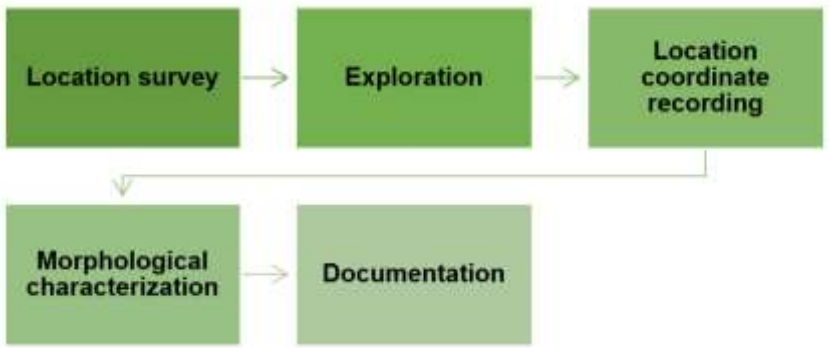

Figure 1. Research flow diagram

3. Results and Discussion

3.1. Banana Distribution Locations on Pagai Island

Based on the results of exploration in 3 sub-districts on Pagai Island, 22 banana plant accessions were obtained with the names as listed in Table 1.

Banana accessions found in Sikakap District include Jantan banana, sarai/sipongit, boji, mendik, buai, super local, sikamung, forest/sukgunei, annak, red/tabbaut, buai, and taksopo. In South Pagai District, banana accessions consist of sweet banana, salinding, babbui, and super, while in North Pagai District, banana accessions include cavendish banana, silopot, local stone, Piter, sibogat, and yellow ambon. The community does not consume two banana accessions: forest banana/sukgunei (considered monkey food) and silopot banana (considered pig food). Generally, kepok bananas are cultivated in the fields by the community, while other types, except for forest bananas/sukgunei and silopot, are grown in yards. Kepok bananas are harvested and sold to areas like Riau and North Sumatra, with some being exported to other countries. According to BPS-Statistics Indonesia data (2024), the main destination countries for Indonesian banana exports are Malaysia, Japan, and Singapore. The distribution of banana plants on Pagai Island, Mentawai Regency, is shown in Figure 2.

3.2. Morphological Characteristics of Bananas on Pagai Island

Based on the observations of morphological characters (qualitative traits), the following features were examined: Pseudostem tapering, Pseudostem anthocyanin coloration, compactness of crown, Growth habit, Petiole attitude of wings at the base, Color of midrib on lower side of the blade, Shape of the base of the leaf blade, Waxiness on lower side of the leaf blade, glossiness of upper side of the leaf blade, Curvature of the peduncle. The diversity observed was limited, except for the glossiness of the upper side of the leaf blade. Environmental and genetic factors play a significant role in the diversity of banana accessions.

Table 1. Accession code, banana name, location coordinates, and elevation of 22 banana accessions from exploration

No	Accession Code	Banana Name	Location Coordinates		Elevation (MASL)
1	P 01	Jantan	S 02.65471◦	E 100.15474◦	32
2	P 02	Sarai/Sipongit	S 02.65479◦	E 100.15464◦	28
3	P 03	Boji	S 02.65482◦	E 100.15463◦	31
4	P 04	Mendik	S 02.65489◦	E 100.15569◦	33
5	P 05	Buai	S 02.65495◦	E 100.15569◦	31
6	P 06	Super Lokal	S 02.65478◦	E 100.15569◦	30
7	P 07	Sikamung	S 02.65493◦	E 100.15528◦	37
8	P 08	Hutan/ Sukgunei	S 02.81752◦	E 100.20377◦	143
9	P 09	Annak	S 02.81754◦	E 100.20361◦	155
10	P 10	Merah/ Tabbaut	S 02.82448◦	E 100.20629◦	97
11	P 11	Buai	S 02.82510◦	E 100.20714◦	79
12	P 12	Taksopo	S 02.82522◦	E 100.20741◦	86
13	P 13	Manis	S 02.98722◦	E 100.27212◦	193
14	P 14	Salinding	S 02.98521◦	E 100.27320◦	223
15	P 15	Babbui	S 02.98580◦	E 100.27305◦	221
16	P 16	Super	S 02.98569◦	E 100.27291◦	218
17	P 17	Cavendish	S 02.79864◦	E 100.14363◦	40
18	P 18	Silopot	S 02.76216◦	E 100.01146◦	2
19	P 19	Batu Lokal	S 02.76817◦	E 100.00928◦	41
20	P 20	Piter	S 02.76587◦	E 100.01154◦	8
21	P 21	Sibogat	S 02.76591◦	E 100.01179◦	10
22	P 22	Ambon Kuning	S 02.76572◦	E 100.01218◦	21

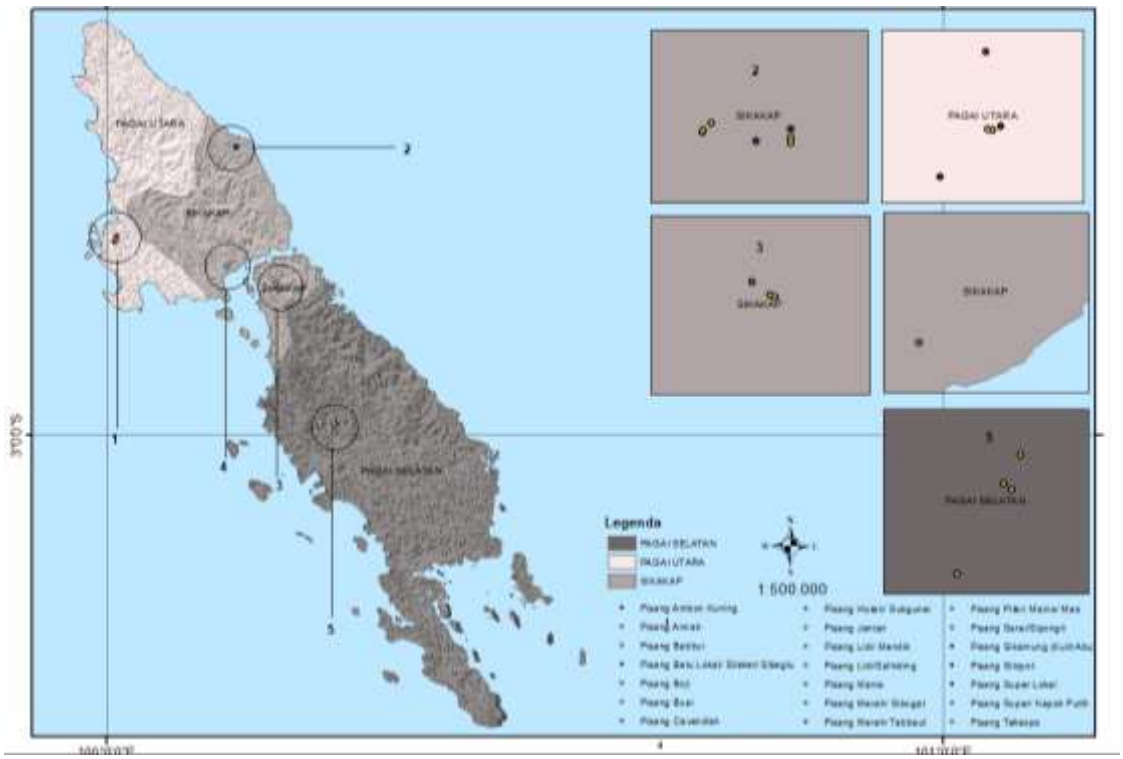

Figure 2. Location of banana plant sample points on Pagai Island, Mentawai Regency.

According to Suranto (2001) and Weihan and Zulkarnain (2020), environmental factors can lead to varying morphological characteristics in the same plant grown in different environments, while genetic factors may result in less variation. Syukur et al. (2012) suggested that simple genes control qualitative traits and are minimally influenced by the environment. In contrast, as noted by Jameela et al. (2014), quantitative traits are significantly affected by environmental factors when the same plant is grown in different environments.

The morphological characterization data can be found in Tables 2, 3, and 4, and visual documentation of banana plant morphology is provided in Figures 3, 4, 5, and 6.

Table 2. Morphological characterization data of banana plant stems.

Characteristics	Expression	Accession
Pseudostem: tapering	absent	P 03, P 04, P 07, P 13, P 14, P 15, P 17, P 19, P 20, P 21, P 22
	medium	P 01, P 02, P 5, P 08, P 09, P 10, P 11, P 16, P 18
	strong	P 06, P 12
Pseudostem: anthocyanin coloration	absent	P 11
	weak	P 02, P 03, P 04, P 07, P 09, P 12, P 16, P 17, P 18, P 19, P 22
	medium	P 01, P 06, P 09, P 13, P 15, P 20
	strong	P 08, P 10, P 21
Plant: compactness of crown	loose	P 01, P 02, P 03, P 04, P05, P 06, P 07, P 08, P 09, P 11, P 12, P 13, P 14, P 15, P 16, P 17, P 18, P 19, P 20, P 22
	medium	P 10, P 21
Plant: growth habit	upright	P 20
	spreading	P 01, P 03, P 05, P 07, P 08, P 10, P 11, P 13, P 15, P 16, P 17, P 18, P 19, P 21, P 22
	drooping	P 02, P 04, P 06, P 09, P 12, P 14

Table 3. Morphological characterization data of banana plant leaves

Characteristics	Expression	Accession
Petiole Petiole: attitude of wings at the base	straight	P 01, P 03, P 06, P 08, P 09, P 10, P 11, P 12, P 13, P 17, P 18, P 20, P 21
	slightly curved inwards	P 05
	moderately curved inward	P 02, P 04, P 07, P 14, P 15, P 16, P 19, P 22
Blade: color of midrib on lower side	green	P 01, P 02, P 03, P 04, P 05, P 06, P 07, P 08, P 09, P 11, P 12, P 13, P 14, P 15, P 16, P 17, P 18, P 19, P 20, P 22
	purple	P 10, P 21
Leaf blade: the shape of base	both sides rounded	P 03, P 07, P 16, P 19, P 22
	One side rounded and one side acute	P 01, P 02, P 04, P 08, P 09, P 10, P 14, P 18, P 21
	both sides acute	P 05, P 06, P 11, P 12, P 13, P 15, P 17, P 20
Leaf blade: Waxiness on lower side	absent	P 02
	present	P 01, P 03, P 04, P 05, P 06, P 07, P 08, P 09, P 10, P 11, P 12, P 13, P 14, P 15, P 16, P 17, P 18, P 19, P 20, P 21, P 22
Leaf blade: glossiness of upper side	absent	P 01, P 02, P 03, P 04, P 08, P 09, P 10, P 11, P 12, P 13, P 15, P 17, P 18, P 19, P 22
	present	P 05, P 06, P 07, P 14, P 16, P 20, P 21

Table 4. Morphological characterization data of banana peduncle

Characteristics	Expression	Accession
Peduncle: curvature	weak	P 01, P 02, P 03, P 05, P 06, P 07, P 10, P 14, P 15, P 17, P 18, P 19, P 20, P 21, P 22
	medium	P 04, P 08, P 09, P 11, P 12, P 13, P 16

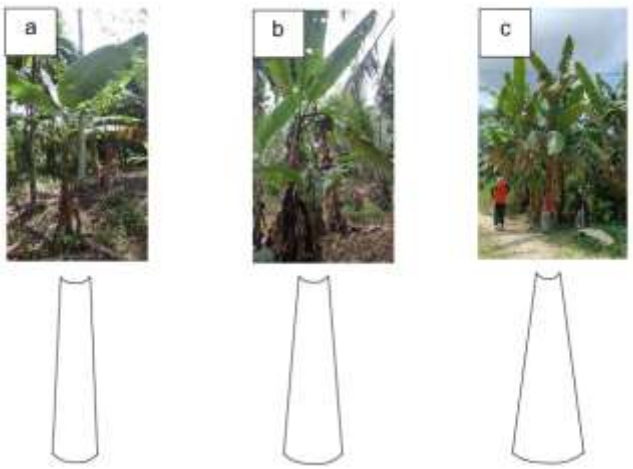

Figure 3. Morphology Pseudo stem: tapering some bananas on Pagai Island: a. absent (P 03), b. medium (P 01), and c. strong (p 12)

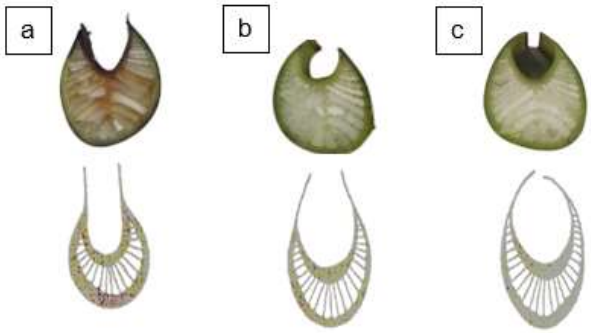

Figure 4. Morphology Petiole Petiole: attitude of wings at the base of some bananas on Pagai Island: a. straight (P 01), b. slightly curved inwards (P 05), and c. moderately curved inward (P 19)

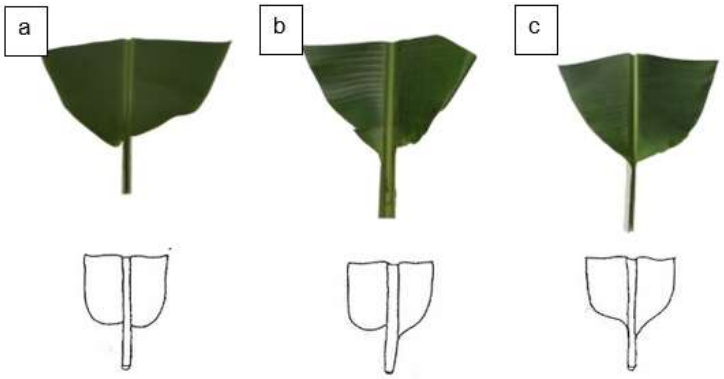

Figure 5. Morphology Leaf blade: the shape of the base of some bananas on Pagai Island: a. both sides rounded (P 03), b. one side rounded and one side acute (P 01), and c. both sides acute (P 11)

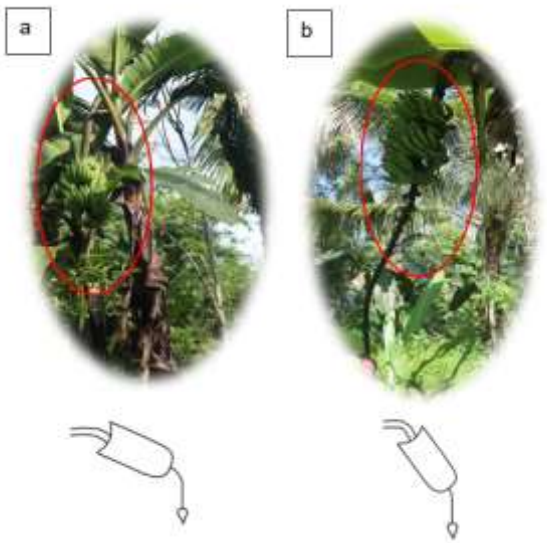

Figure 6. Morphology Peduncle: curvature some bananas on Pagai Island: a. weak (P 05) and b. medium (P 04)

Cluster analysis examined the dendrogram based on the morphology of the characterized banana plant accessions. The goal was to determine if the 22 bananas found on Pagai Island have different genetics or if some have the same genetics but are named differently in each location. The study by Dwivany et al. (2020) revealed that the spread of bananas from one region to another leads to name variations, but DNA analysis showed that different names correspond to the same genetics. The results of the analysis of 22 banana accessions on Pagai Island based on several morphological characters are presented in Figure 7.

Figure 7 illustrates that the 22 banana accessions on Pagai Island exhibit a similarity level ranging from 42% to 100% based on 10 observed morphological characteristics.

At a similarity level of 42%, the banana accessions are grouped into two clusters: cluster 1 comprising accessions P 10 and P 21, and cluster 2 comprising P 01, P 02, P 03, P 04, P 05, P 06, P 07, P 08, P 09, P 11, P 12, P 13, P 14, P 15, P 16, P 17, P 18, P 19, P 20, and P 22. At a similarity level of 53%, the banana accessions are further divided into two sub-clusters: cluster 1a including accessions P 02, P 03, P 04, P 05, P 06, P 07, P 10, P 14, P 15, P 16, P 17, P 19, P 20, P 21, and P 22, and cluster 2a comprising accessions P 01, P 08, P 09, P 11, P 12, P 13, and P 18—notably, accessions P 19 and P 22 exhibit a 100% similarity level.

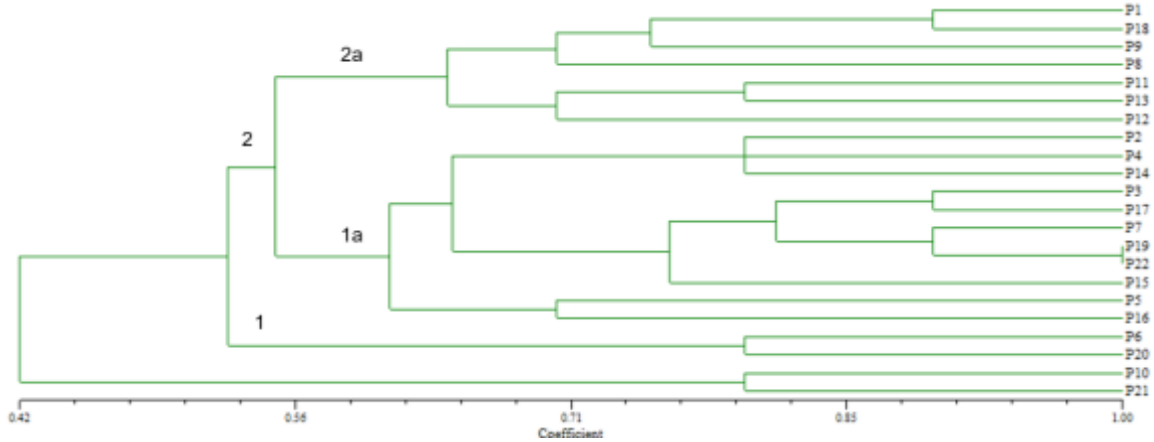

Figure 7. Results of cluster analysis of 22 banana accessions on Pagai Island based on several morphological (qualitative) characteristics.

Cluster analysis (kinship) assesses the kinship relationships among individuals in a plant population based on morphological traits (Weihan R and Zulkarnain, 2020). Studies by Wijayanto et al. (2013) and Nedha et al. (2017) suggest that a smaller genetic distance indicates a closer kinship relationship, while a greater genetic distance signifies a more distant kinship relationship. The genetic diversity of bananas in Indonesia is considered high, and relying solely on phenotypic identification may yield less accurate results due to the instability of some morphological characters (Wijayanto et al., 2013; Retnoningsih et al., 2010). To enhance the accuracy of clustering results, comprehensive morphological characterization of the studied plants is recommended (Mashar MF, 2018).

4. Conclusion

The research conducted has yielded insights into the distribution of banana cultivars on Pagai Island within the Mentawai Islands Regency. A total of 22 banana accessions were examined, and based on their morphological characteristics, they exhibited a similarity level ranging from 42% to 100%.

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