

## Inventory of the Genus *Bougainvillea* (Nyctaginaceae) at Bukit Bougenville Agrotourism Park, Singkawang, West Kalimantan

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**Abstract:** The high level of biodiversity Indonesia contains is a prestigious national treasure. One type of biodiversity found in Indonesia is plant diversity. Plant diversity is inevitable due to their use as ornamental plants. Among many ornamental plants famous in Indonesia, the genus *Bougainvillea* Comm. ex Juss is known globally for its essential role in horticulture development. Bukit Bougenville Agrotourism Park, located in Sijangkung Subdistrict, South Singkawang District, Singkawang City, West Kalimantan Province, maintains a diverse and abundant collection of cultivated *Bougainvillea* plants, which can serve as an important resource for investigating *Bougainvillea* diversity. To date, no research has inventoried the diversity of *Bougainvillea* in Bukit Bougenville Agrotourism Park. Therefore, this research aims to inventory and identify members of the *Bougainvillea* genus found in Bukit Bougenville Agrotourism Park. Using a qualitative method, this research involved the *Bougainvillea* members at the research site, sampled using convenience sampling due to the vast area. The research is then continued with identification based on morphology, supported by various peer-reviewed literature. The identification process revealed two species: *Bougainvillea spectabilis* Willd., both in non-variegated and variegated forms, and *Bougainvillea glabra* Choisy. The sampling also revealed substantial numbers of each species in Bukit Bougenville Agrotourism Park: *B. spectabilis* in non-variegated form, totalling 237 individuals; *B. spectabilis* in variegated form, totalling 126 individuals; and *B. glabra*, totalling 53 individuals, for a total of 416 individuals encountered throughout the sampling period. The identification and abundance of the two species indicate that the area has favorable ecological conditions for cultivating *Bougainvillea*, supporting its role as a specialized agrotourism destination. Overall, the results provide a baseline inventory for future planning regarding conservation, landscape management, and ornamental plant breeding programs. Moreover, the documented species composition can inform agrotourism development strategies, including educational interpretation, biodiversity-based tourism promotion, and sustainable plant management practices.

**Keywords:** Agrotourism Park; Biodiversity; *Bougainvillea*; Bukit Bougenville; Nyctaginaceae.

### Introduction

Indonesia is known as one of the tropical countries with a tremendous level of biodiversity [1], [2]. Biodiversity itself provides various natural resources and alternatives that communities can widely utilize for their daily needs [3]. One form of biodiversity utilization often encountered is the use of plants as ornamentals. Ornamental plants are a group of plants that primarily serve as decoration due to their aesthetic value [4], [5]. Ornamental plants are in high demand among Indonesians, as indicated by the wide variety of species and the large number found in home gardens and various public spaces. The high diversity of ornamental plants in Indonesia demonstrates how biodiversity can be sustainably utilized without reducing its ecological value. In addition to their aesthetic value, ornamental plants improve air quality [6] and support human mental health [7]. One genus of ornamental plants commonly found is *Bougainvillea* Comm. ex Juss.

The genus *Bougainvillea* belongs to the family Nyctaginaceae, which is part of the order Caryophyllales, class Magnoliopsida, and phylum Magnoliophyta [8]. The genus *Bougainvillea* originates from South America and was first described and studied by Philibert Commerson in Brazil in 1766–1769 [9]. The genus *Bougainvillea*, known as

“bunga kertas” by Indonesians, is known globally for its significant role in the development of horticulture, mainly because of the color of its bracts, commonly known as “flowers”, consisting of bracts, brightly colored and conspicuous parts, and small white true flowers [10]. In addition to being an ornamental plant, *Bougainvillea* is also known to have medicinal properties [11], the ability to be used as a textile dye [12], and as an ingredient in the development of functional beverages [13]. Bukit Bougenville Agrotourism Park hosts a substantial collection of *Bougainvillea* plants, making it a valuable resource for studying the diversity of the genus.

Bukit Bougenville Agrotourism Park is located in Sijangkung Subdistrict, South Singkawang District, Singkawang City, West Kalimantan Province. Located approximately 6 kilometers from the center of Singkawang City, Bukit Bougenville Agrotourism Park, inaugurated in 2001, covers approximately 1.5 hectares and features various attractive plants [14]. As its name suggests, Bukit Bougenville Agrotourism Park’s main attraction is its extraordinary members from the *Bougainvillea* genus. Therefore, it is important to identify the *Bougainvillea* genus in this park. Inventorying the *Bougainvillea* genus is important for documenting its morphological and species

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diversity, which serves as a basis for germplasm conservation. In addition, inventorying the *Bougainvillea* genus can support optimizing its use in horticulture, education, and landscape development.

Previous research has examined the diversity of the *Bougainvillea* genus in Indonesia. Afrina et al. [15] found six species in Medan Johor District, Medan City, North Sumatra Province. Syam et al. [16] studied four cultivars from Seneren Village, Pantan Cuaca District, Gayo Lues Regency, Aceh Province. Apriyanti [17] successfully identified nine varieties in Paya Tambah Village, Karang Baru District, Aceh Tamiang Regency, Aceh Province. However, no research has been conducted to inventory the diversity of the *Bougainvillea* genus in Bukit Bougenville Agrotourism Park. Therefore, this research aims to inventory and identify members of the *Bougainvillea* genus found in Bukit Bougenville Agrotourism Park. This research is expected to provide basic data on the diversity of the *Bougainvillea* genus in previously undocumented agrotourism areas. Given its high morphological diversity, this research emphasizes the importance of systematic documentation and characterization for identifying the *Bougainvillea* genus, which can be challenging.

**Research Methods**

This research is qualitative. Sampling of the *Bougainvillea* genus was conducted in April 2024 at Bukit Bougenville Agrotourism Park, Singkawang City, while identification of the samples obtained was conducted in May 2024 at the Biology Education Laboratory, Universitas Tanjungpura, Pontianak City. A sample area of Bukit Bougenville Agrotourism Park is presented in Figure 1. The population in this research was the *Bougainvillea* genus found in Bukit Bougenville Agrotourism Park. Meanwhile, the sampling technique used was convenience sampling due to the heterogeneous distribution of plants across the extensive research area. In addition, convenience sampling has certain advantages, as it can yield higher species diversity by covering larger areas [18]. The identification of

members of the *Bougainvillea* genus obtained at the research site was carried out by matching the morphology of the samples obtained with the results of research contained in peer-reviewed research articles and the book “*Teknologi Pembiakan Vegetatif Tanaman Hias: Program Rumah Vegetatif Tanaman Hias (RUVETAS) Guna Meningkatkan Kesejahteraan Masyarakat di Desa Sipungguk, Kabupaten Kampar, Riau*” [19]. The identification results were then validated using data from the Plants of the World Online ([powo.science.kew.org](http://powo.science.kew.org)) website. To strengthen the reliability of identification results, each member of the research team independently verified each species, and discrepancies were resolved through reexamination of morphological characters. However, this research represents an initial inventory, enabling future research to incorporate replication and molecular approaches to improve accuracy.



**Figure 1.** Bukit Bougenville Agrotourism Park

**Results and Discussion**

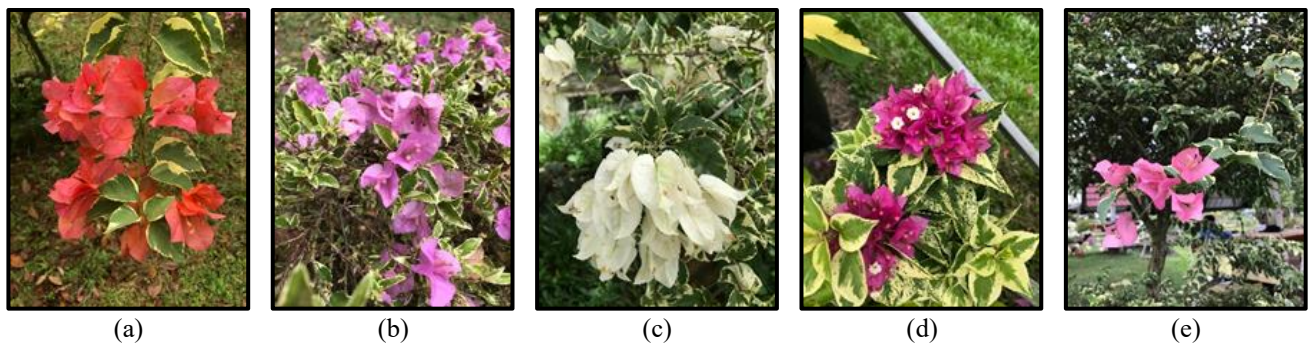
This research is the first to assess the diversity of the *Bougainvillea* genus found in Bukit Bougenville Agrotourism Park, Singkawang City. Biodiversity inventory is among the significant challenges for conservation biology nowadays in the face of global change [20], making this research important for advancing research on plant diversity. Table 1 presents the results of the inventory of the genus *Bougainvillea*, including two species: *Bougainvillea spectabilis* Willd. (non-variegated and variegated forms) and *Bougainvillea glabra* Choisy.

**Table 1.** *Bougainvillea* species found in Bukit Bougenville Agrotourism Park

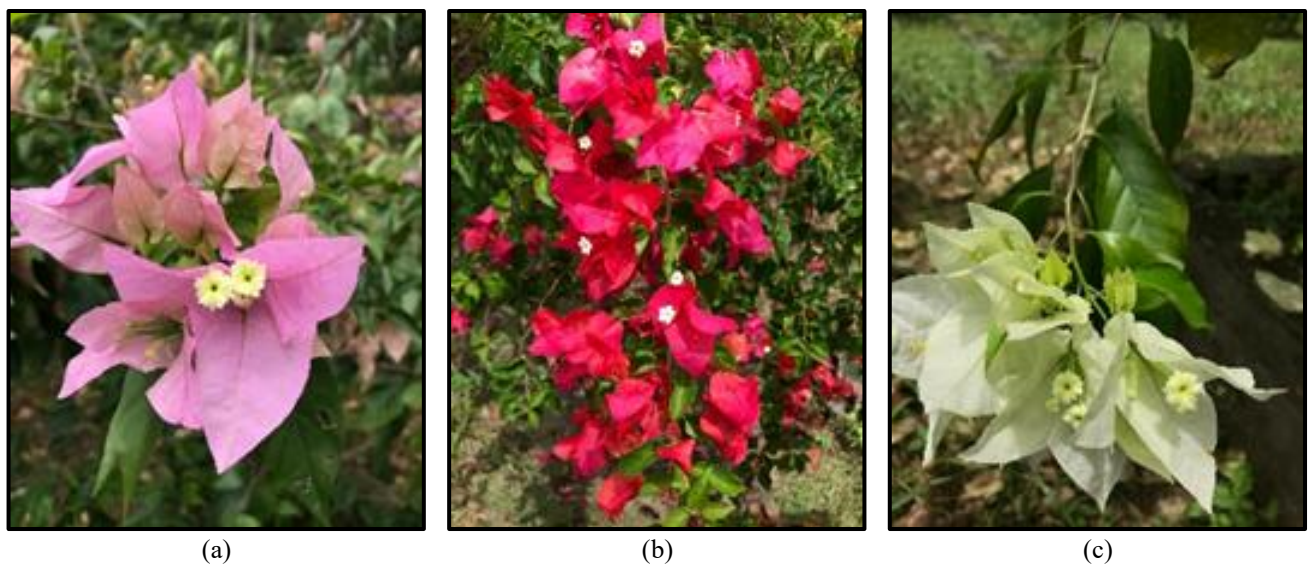
No.	Species	Color Variety	Amount
1	<i>Bougainvillea spectabilis</i> (non-variegated)	Yellow	34
		Magenta	88
		White	18
		Purple	50
		Pink	9
		Purple-white	18
		Light purple	14
		Red	6
Total			237
2	<i>Bougainvillea spectabilis</i> (variegated)	Orange	3
		Purple	54
		White	66
		Dark purple	1
		Pink	2
Total			126
3	<i>Bougainvillea glabra</i>	Light purple	22
		Magenta	10
		White	21
Total			53
Total Amount of All Species			416



**Figure 2.** *Bougainvillea spectabilis* (non-variegated): (a) yellow, (b) magenta, (c) white, (d) purple, (e) pink, (f) purple-white, (g) light purple, and (h) red



**Figure 3.** *Bougainvillea spectabilis* (variegated): (a) orange, (b) purple, (c) white, (d) dark purple, and (e) pink

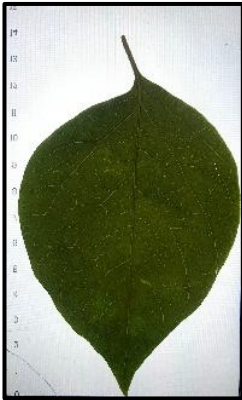

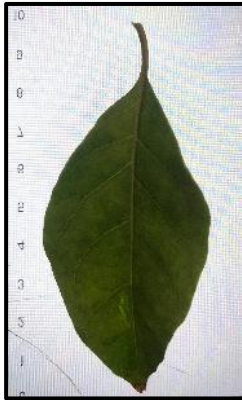
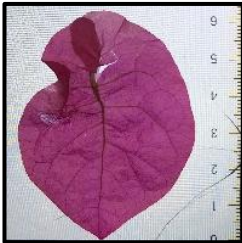







**Figure 4.** *Bougainvillea glabra*: (a) light purple, (b) magenta, and (c) white

Non-variegated *B. spectabilis* is shown in Figure 2, variegated *B. spectabilis* is presented in Figure 3, and *B. glabra* can be seen in Figure 4. As visible within the figures, the central attractive organ of members of the *Bougainvillea* genus is the bract. Bracts are non-flower organs that form part of the flower—they are specialized leaves with highly diverse morphologies that function to protect the plant, attract pollinators, disperse seeds, adapt to abiotic factors, and play a role in photosynthesis [21]. The inventory results show a wide variety of bract colors across the species, with non-variegated *B. spectabilis* having the most (eight) and *B. glabra* having the fewest (three). Liu et al. [22] suggested that the pigments contributing to the various colors of bracts in the genus *Bougainvillea* are generally known to be formed similarly to the leaves of variegated plants. More specifically, the color of bracts in ornamental plants is a

complex trait influenced by a wide variety of pigments (chlorophyll, anthocyanins, betalains, and carotenoids) and their biosynthetic pathways and regulatory networks [23]. Betalain, found in various families in the order Caryophyllales [24], is the pigment type that plays a dominant role in the coloring of *Bougainvillea* bracts, where betaxanthins and betacyanins are capable of producing colors in the yellow and red spectrums, respectively, with red bracts containing significantly higher concentrations of betacyanins [23]. The findings of this research also reveal that non-variegated *B. spectabilis* is the only species to exhibit a combination of two colors on its bracts, as indicated by the presence of 18 individuals with the color variety purple-white. The diverse color spectrum of plant bracts indicates that there are differences in the combination and level of accumulation of betalains [25], [26].

**Table 2.** Comparison of the morphology aspects between the *Bougainvillea* members found

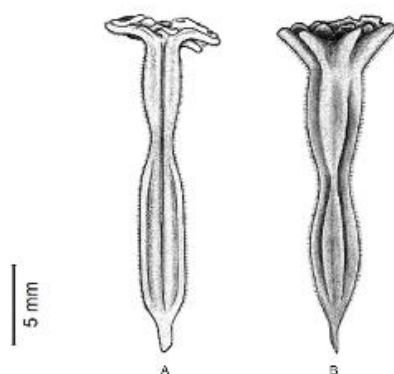
No.	Aspect	<i>Bougainvillea spectabilis</i> (Non-variegated)	<i>Bougainvillea spectabilis</i> (Variegated)	<i>Bougainvillea glabra</i>
1	Leaf			
2	Bract			
3	Flower (perianth tube)			

*Bougainvillea spectabilis* and *B. glabra* shared general morphological similarities, including a shrub habit and round, brown, woody stems with thorny surfaces. However, this research focuses on three morphological aspects that distinguish *B. spectabilis*, both non-variegated

and variegated, from *B. glabra*. Table 2 presents morphological differences across three aspects: leaves, bracts, and perianth tubes. Although both have tapered leaf tips and bases, light to dark green leaf color, and flat leaf edges, there are differences in shape, with *B. spectabilis*

having oval leaves and *B. glabra* having elliptical leaves. In addition, *B. spectabilis* and *B. glabra* have differences in leaf surface; *B. spectabilis* has a rough leaf surface, while *B. glabra* has a glossy leaf surface. This is in line with the findings of Shaheen et al. [27], who compared *B. spectabilis* and *B. glabra* in Pakistan, where the leaves of *B. spectabilis* were found to be ovate with a fine hairy surface, while those of *B. glabra* were ovate-lanceolate with a smooth, paper-like texture. Specifically for *B. spectabilis*, there is a significant difference in color between the non-variegated form and the variegated form. Non-variegated *B. spectabilis* has completely green leaves, while variegated *B. spectabilis* has leaves with white patterns. Variegated leaves are leaves with areas of non-green colors [28]. Leaf variegation is a phenomenon driven by various genetic, developmental, and physiological factors that play roles in protection [29], reproduction, and adaptation to the environment [28].

The bracts of *B. spectabilis* and *B. glabra* differ at the base, where *B. spectabilis* has a notched base, and *B. glabra* has a rounded base. Although the size and shape of the bracts of members of the genus *Bougainvillea* are very diverse [30]. The findings in this research show that the bracts of *B. spectabilis* are more elongated compared to those of *B. glabra*. Meanwhile, the results of flower part identification show that both have a perianth tube with a constriction in the middle. Furthermore, the difference between the perianth tubes of both species can be seen from the size of the upper and lower sections of the constriction in the middle. *Bougainvillea spectabilis* has a perianth tube with an upper section that is the same size or larger than the lower section, while *B. glabra* has a perianth tube with a lower section larger than the upper section. This is consistent with the analysis by Bautista et al. [31] (illustrated in Figure 5), which shows apparent morphological differences between the flowers of *B. spectabilis* and *B. glabra*.



**Figure 5.** Comparison between flowers: (a) *B. glabra* and (b) *B. spectabilis* (adapted from Bautista et al. [31]; *Plants*, Multidisciplinary Digital Publishing Institute, licensed under CC BY 4.0 [<https://creativecommons.org/licenses/by/4.0/>]; the image was cropped to highlight relevant details.

The results of this research indicate that identifying *Bougainvillea* solely on morphological criteria is very challenging. As a highly popular ornamental plant in various parts of the world, various colorful varieties and innovations of *Bougainvillea* have been developed through shoot mutation, seed selection, chromosome manipulation, and induced mutation [32]. The existence of numerous varieties indicates that the characteristics of *Bougainvillea* are

challenging to study solely through morphology—as *Bougainvillea* varieties tend to have very similar morphological traits—requiring research that employ more advanced methodologies. In addition, the large number of *Bougainvillea* varieties indicates that the classification of this genus is still extremely chaotic [10]. However, many research state that *B. spectabilis* and *B. glabra* are two widely recognized and important native species in horticultural aspects, in addition to *Bougainvillea peruviana* Bonpl. (e.g. [32], [33]). Therefore, this research highlights the main limitation that the inventory of *Bougainvillea* genus members conducted at Bukit Bougenville Agrotourism Park is limited to morphology. Based on the limitation, further research is proposed to examine each individual of the *Bougainvillea* genus found in Bukit Bougenville Agrotourism Park through a molecular approach, similar to that demonstrated in research by Rastogi et al. [34], Bautista et al. [35], Bautista et al. [31], and Ma et al. [32].

## Conclusion

Based on the research conducted, it can be concluded that Bukit Bougenville Agrotourism Park consists of non-variegated *B. spectabilis*, variegated *B. spectabilis*, and *B. glabra* in large numbers (416 in total), considering that the diversity of members of the *Bougainvillea* genus is the main attraction at this location. The results of this research can enrich inventory data on ornamental biodiversity in Indonesia, especially in West Kalimantan. The high abundance and variety of colors of the *Bougainvillea* genus members found in Bukit Bougenville Agrotourism Park confirm the potential of this location as a biodiversity-based agrotourism destination that can serve as a visual attraction and educational medium for visitors. Furthermore, the results of this research imply that further conservation and landscape management efforts are needed. The data on the composition and number of individuals of the *Bougainvillea* genus obtained through this research can serve as a basis for decision-making on plant collection management, sustainable planting planning, and the maintenance of the area's aesthetic and ecological balance. However, this research is limited to identification based solely on morphological characteristics. Therefore, further research is recommended to analyze the diversity of *Bougainvillea* in Bukit Bougenville Agrotourism Park through a molecular approach to obtain more accurate identification results.

## Authors' Contribution

N.A.K. Ayu: Conceptualization, data curation, formal analysis, investigation, methodology, visualization, writing-original draft. W. Astuti: Conceptualization, formal analysis, investigation, methodology, and writing-original draft. Isyatirradhiyah: Conceptualization, formal analysis, investigation, methodology, and writing-original draft. H. Fajri: Methodology, project administration, supervision, and writing-original draft. M.A. Faturrahman: Methodology, supervision, and writing-original draft.

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