INTERNATIONAL JOURNAL OF RESEARCH AND SCIENTIFIC INNOVATION (IJRSI)
ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

Plant Inventory and Taxonomic Classification of Spermatophyta in a University Campus Ecosystem

Mia Cholvistaria., Beny Saputra., Ade Gunawan

Faculty of Teacher Training and Education, Muhammadiyah University of Metro, Indonesia

DOI: https://doi.org/10.51244/IJRSI.2026.1306000142

Received: 06 June 2026; Accepted: 11 June 2026; Published: 27 June 2026

ABSTRACT

Understanding plant diversity in semi-managed ecosystems is essential for biodiversity conservation and environmental education. This study aims to inventory and classify Spermatophyta species within two university campus sites and analyze their taxonomic composition and distribution patterns. An exploratory descriptive method was employed through field observations, documentation, and morphological identification of plant species. The collected data were classified taxonomically from kingdom to species level and analyzed descriptively. The results revealed a total 30 plant species belonging to both Gymnospermae and Angiospermae, with Angiospermae being the dominant group. Monocotyledonae were primarily represented by Arecaceae and Asparagaceae, while Dicotyledonae showed higher diversity across families such as Euphorbiaceae, Apocynaceae, Myrtaceae, and Sapindaceae. Campus 3 exhibited greater species richness compared to Campus 1, reflecting differences in landscape management and plant utilization. Functional analysis indicated the presence of ornamental, fruit-bearing, medicinal, and shade plants, highlighting the multifunctional role of campus vegetation. These findings demonstrate that university campuses function as important microhabitats for plant diversity and provide valuable resources for ecological studies and biology education. The study contributes to urban biodiversity knowledge and supports the integration of field-based learning in plant taxonomy.

Key words: plant diversity; Spermatophyta; taxonomy; campus biodiversity; plant inventory

INTRODUCTION

Plant diversity is a fundamental component in maintaining ecosystem stability, particularly in urban and semi-managed environments that are increasingly subjected to pressures from habitat fragmentation and intensive development. In this context, campus green spaces play a crucial ecological role as biodiversity refugia, supporting both flora and fauna communities while providing habitats for various organisms within continuously changing urban landscapes. Several studies have demonstrated that university campuses can function as biodiversity hotspots, characterized by high plant species richness and significant contributions to sustaining urban ecological functions, including habitat provision, pollinator support, and environmental quality improvement (Wang et al., 2021; Winkler et al., 2022; Singh et al., 2024; Susilowati et al., 2021).

Beyond their ecological significance, campus vegetation also contributes to a wide range of ecosystem services. Plant communities within campus green spaces are known to support carbon sequestration, mitigate urban heat island effects, regulate stormwater, improve air quality, and provide aesthetic value as well as psychological benefits for academic communities (Yadav, 2025; Giao & Truong, 2024; Lee et al., 2025; Yerokhin et al., 2024). Moreover, vegetation diversity is positively correlated with the presence of other faunal groups such as birds, butterflies, and pollinating insects, indicating that campuses function not merely as passive green spaces but as dynamic and multifunctional ecological systems (Liang et al., 2020; Arjona et al., 2023; Serret et al., 2022). Therefore, studies on campus vegetation are essential not only for biodiversity conservation but also for the sustainable management of green spaces in higher education environments.

Among the plant groups composing campus vegetation, Spermatophyta occupies a central position as it encompasses seed plants that dominate managed terrestrial ecosystems, including both Gymnosperms and Angiosperms. Spermatophytes exhibit a wide range of growth forms, from herbs and shrubs to ground covers and canopy trees, thereby forming the structural and functional foundation of urban vegetation communities. In numerous inventories conducted in campus green spaces and other urban vegetated areas, Angiosperms consistently emerge as the dominant group, whereas Gymnosperms are typically represented by a limited number of ornamental or introduced species (Khan et al., 2021; Lahoti et al., 2020; Kimpouni et al., 2023; Gristina et al., 2025). This dominance is associated with the broader ecological adaptability of Angiosperms, their diverse life forms, and their high functional value in landscape planning and vegetation management.

Spermatophyta (seed plants), encompassing both Gymnosperms and Angiosperms, constitute the dominant plant group in managed urban vegetation and play a crucial role in the ecological functioning of campus ecosystems (Susilowati et al., 2021; Hasan et al., 2023; Vourlitis et al., 2022). Their structural diversity ranging from ground cover and herbaceous species to shrubs and canopy-forming trees creates habitat heterogeneity that is essential for supporting diverse animal communities (Arjona et al., 2023; Liang et al., 2020). The deliberate selection and management of Spermatophyte species in campus landscape design are therefore critical for enhancing biodiversity and establishing ecologically balanced environments (Yerokhin et al., 2024; Hasan et al., 2023).

Campus plant biodiversity in managed vegetated areas supports a broad range of ecosystem services. These include carbon sequestration, mitigation of the urban heat island effect, stormwater regulation, air quality improvement, and habitat provision (Yadav, 2025; Susilowati et al., 2021; Giao & Truong, 2024; Lee et al., 2025). A comparative study of urban green space types reported that university campuses sustain higher tree diversity and function as biodiversity centers while also contributing substantially to carbon storage (Yadav, 2025). Likewise, campus trees have been shown to sequester carbon annually; a study conducted on a South Korean university campus recorded aboveground carbon storage of 263.9 Mg C across 28.7 ha of green space (Lee et al., 2025). These findings indicate that campus vegetation should be recognized not only as an ornamental component of institutional landscapes but also as a key ecological asset that contributes directly to urban environmental sustainability.

In addition to provisioning and regulating services, plant biodiversity in campus ecosystems also contributes to cultural ecosystem services, particularly through its aesthetic value and its positive effects on students' mental well-being (Yerokhin et al., 2024; Giao & Truong, 2024). Evidence from Can Tho University, Vietnam, showed that students perceived air temperature regulation, oxygen production, and aesthetic value as the most important ecosystem services provided by campus green spaces (Giao & Truong, 2024). This suggests that the ecological importance of campus vegetation extends beyond biophysical functions to include social and educational dimensions. Therefore, maintaining diverse plant assemblages in university campuses is essential not only for biodiversity conservation and environmental management but also for enhancing the quality of academic life and supporting a healthier campus environment.

From a scientific perspective, understanding Spermatophyte diversity cannot be separated from accurate plant inventory and taxonomic classification. Plant taxonomy serves as the foundation of biodiversity research, enabling the identification, naming, and systematic classification of species, thereby allowing patterns of species richness, distribution, and conservation value to be analyzed scientifically (Victor et al., 2024; Marín-Rodulfo et al., 2024; Borsch et al., 2020). Practically, plant inventory in campus environments is essential for developing local flora databases, supporting vegetation planning, strengthening ex situ conservation efforts, and enhancing environment-based learning. Campuses with well-documented flora have strong potential to be developed into natural laboratories, educational arboreta, and contextual learning resources in botany, plant taxonomy, and ecology courses.

Accurate taxonomy is a prerequisite for identifying biodiversity patterns at local, regional, and global scales. Plant checklists—such as the National Plant Checklist of South Africa, which includes more than 23,000 taxa—serve as a fundamental basis for floristic research and continue to evolve through ongoing taxonomic work (Victor et al., 2024). The World Checklist of Vascular Plants, when integrated with threat assessment databases, has been used to evaluate the completeness of conservation assessments for endemic flora across 179 countries, revealing that 58% of all country-endemic species remain unevaluated (Gallagher et al., 2023). This taxonomic shortfall directly constrains the identification of biodiversity hotspots and the prioritization of conservation resources (Hochkirch et al., 2020; Gallagher et al., 2023).

The consequences of taxonomic misidentification on conservation outcomes have been well documented and can be severe. A case study involving the rare conifer Abies hickelii in Mexico demonstrated that taxonomic confusion with the commercially valuable A. religiosa led simultaneously to unintended population increases through misidentified reforestation programs and to illegal logging of the rare species, resulting in significant ecological and legal implications (Vázquez-Ramírez, 2025). This case clearly illustrates that accurate taxonomy in biodiversity conservation is not merely an academic concern but has direct, real-world consequences for species survival. Similarly, Zaman et al. (2024) emphasized that taxonomy and conservation are intrinsically linked, as the former provides the essential foundation for understanding and protecting biodiversity, as demonstrated through anatomical studies of the leaf epidermis of the endemic species Aster glehnii.

Based on these considerations, this study is important to provide empirical insights into the species composition, taxonomic structure, and distribution patterns of Spermatophytes across two university campus locations. Specifically, this study aims to inventory and classify Spermatophyte species and to analyze their taxonomic composition and distribution within semi-managed campus ecosystems. The findings are expected to contribute to the growing body of knowledge on urban biodiversity, support data-driven campus vegetation management, and strengthen the integration of field-based learning approaches in plant taxonomy and ecological studies.

MATERIALS AND METHODS

Voucher Specimen Collection Method

Voucher specimen collection is a standard procedure in plant taxonomy that is applied when field identification cannot be determined with certainty. A voucher specimen serves as a physical record that allows the identity of a species to be verified by other researchers in the future (Greene et al., 2023). As noted in the ethnobotanical literature, "voucher specimen collection facilitates the identification of plants and animals encountered during research and allows colleagues to review study findings" (Greene et al., 2023).

An ideal voucher specimen is a representative dried sample of a plant that includes multiple morphological parts. In general, the collected material should include the branching structure, such as twigs and stems that show the architectural pattern of branching (Greene et al., 2023); leaves, including the adaxial and abaxial surfaces as well as petiole characters (Greene et al., 2023; Deng et al, 2024); flowers, whose characters are especially important for distinguishing closely related species (Ragavan et al., 2019; Deng et al, 2024); and fruits, which also provide crucial taxonomic characters for species identification (Zhu et al., 2023; Ullah et al, 2021).

Practical guidelines for sampling in studies of flower and fruit development further emphasize the importance of collecting material representing different developmental stages, from early and intermediate stages to mature fruits (Deng et al, 2024). In addition, close-up photographs of flowers, fruits, and inflorescences from multiple angles are recommended, together with photographs of stems and leaves that clearly show branching structure (Greene et al., 2023).

Taxonomic Identification Using Morphological Characteristics

Morphological characterization remains the primary approach for plant taxonomic identification in field-based research (Rehem et al., 2020; Singh et al., 2021; Aneklaphakij et al., 2020; Villaseñor & Meave, 2022). Classical taxonomy is largely based on floral morphology; therefore, specimens are preferably collected when flowering and/or fruiting to facilitate identification (Rehem et al., 2020; Singh et al., 2021). In a study conducted in the Southern Bahia Atlantic Forest, all collected plants were intentionally sampled in flowering and/or fruiting condition to support identification, since "taxonomy is based on the classical characters of floral morphology" (Rehem et al., 2020).

Field identification relies on the examination of both vegetative and reproductive characters, including leaf morphology (shape, margin, venation, surface texture, and indumentum), stem characteristics, inflorescence

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

structure, floral morphology, as well as fruit and seed characters (Singh et al., 2021; Aneklaphakij et al., 2020; Villaseñor & Meave, 2022).

Leaf epidermal anatomy has also proven to be a highly valuable taxonomic tool for species identification and differentiation. Scanning electron microscopy of Aster glehnii revealed several diagnostic characters, including stomatal density, stomatal type (anomocytic), epidermal cell shape, anticlinal wall configuration, cuticle thickness, and vein density, all of which provide reliable references for the taxonomic identification of this endemic species (Zaman et al., 2024). Similarly, in the Artocarpus species complex in Thailand, detailed morphological examination of leaf surfaces under stereomicroscopy particularly the presence and density of hairs in the areoles provided key diagnostic characters for species differentiation, although morphological variation within and among specimens required integration with molecular evidence (Aneklaphakij et al., 2020).

Table 1. Inventory of Spermatophyte Species and Their Taxonomic Classification in the University Campus Ecosystem

No	Location	Local Name	Scientific Name	Family	Group
1	Campus 1	Ketapang	Terminalia catappa	Combretaceae	Dicotyledonae
2	Campus 1	Pulai	Alstonia scholaris	Apocynaceae	Dicotyledonae
3	Campus 1	Puring	Codiaeum variegatum	Euphorbiaceae	Dicotyledonae
4	Campus 1	Palm	Arecaceae sp.	Arecaceae	Monocotyledonae
5	Campus 1	Soka	Ixora sp.	Rubiaceae	Dicotyledonae
6	Campus 1	Suji	Dracaena angustifolia	Asparagaceae	Monocotyledonae
7	Campus 1	Fan Palm	Licuala sp.	Arecaceae	Monocotyledonae
8	Campus 1	Tukus	Typhonium flagelliforme	Araceae	Monocotyledonae
9	Campus 1	Copperleaf	Acalypha siamensis	Euphorbiaceae	Dicotyledonae
10	Campus 1	Norfolk Pine	Araucaria heterophylla	Araucariaceae	Gymnospermae
11	Campus 1	Casuarina	Casuarina equisetifolia	Casuarinaceae	Dicotyledonae
12	Campus 1	Privet	Ligustrum ovalifolium	Oleaceae	Dicotyledonae
13	Campus 1	Serut	Streblus asper	Moraceae	Dicotyledonae
14	Campus 1	Papaya	Carica papaya	Caricaceae	Dicotyledonae
15	Campus 1	Mexican petunia	Ruellia simplex	Acanthaceae	Dicotyledonae
16	Campus 3	Bromelia	Alcantarea imperialis	Bromeliaceae	Monocotyledonae
17	Campus 3	Pygmy date palm	Phoenix roebelenii	Arecaceae	Monocotyledonae
18	Campus 3	Moss rose	Portulaca grandiflora	Portulacaceae	Dicotyledonae
19	Campus 3	Yucca	Yucca aloifolia	Asparagaceae	Monocotyledonae
20	Campus 3	Fan palm	Licuala grandis	Arecaceae	Monocotyledonae
21	Campus 3	Foxtail fern	Asparagus densiflorus	Asparagaceae	Monocotyledonae
22	Campus 3	Mast tree	Polyalthia longifolia	Annonaceae	Dicotyledonae
23	Campus 3	Avocado	Persea americana	Lauraceae	Dicotyledonae
24	Campus 3	Dragon tree	Dracaena marginate	Asparagaceae	Monocotyledonae
25	Campus 3	Chinese juniper	Juniperus chinensis	Cupressaceae	Gymnospermae

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue VI June 2026

26	Campus 3	Coconut	Cocos nucifera	Arecaceae	Monocotyledonae
27	Campus 3	Mango	Mangifera indica	Anacardiaceae	Dicotyledonae
28	Campus 3	Crown of thorns	Euphorbia milii	Euphorbiaceae	Dicotyledonae
29	Campus 3	Gandarusa	Justicia gendarussa	Acanthaceae	Dicotyledonae
30	Campus 3	Cashew	Anacardium occidentale	Anacardiaceae	Dicotyledonae
31	Campus 3	Traveler's palm	Ravenala madagascariensis	Strelitziaceae	Monocotyledonae
32	Campus 3	Red palm	Cyrtostachys renda	Arecaceae	Monocotyledonae
33	Campus 3	Yellow iris	Iris pseudacorus	Iridaceae	Monocotyledonae

Table 1 presents the inventory of 33 Spermatophyte species recorded from two university campus locations, namely Campus 1 and Campus 3. Overall, the vegetation composition was clearly dominated by Angiosperms, comprising both Monocotyledonae and Dicotyledonae, while Gymnosperms were represented by only a very limited number of species. Of the total recorded species, only two Gymnosperm taxa were identified, namely Araucaria heterophylla in Campus 1 and Juniperus chinensis in Campus 3, indicating that this group contributed only a minor component to the overall campus flora.

Within the Angiosperms, Monocotyledonae were strongly represented by members of the family Arecaceae, making this family the most dominant taxonomic group in the study area. Species such as Arecaceae sp., Licuala sp., Phoenix roebelenii, Licuala grandis, Cocos nucifera, and Cyrtostachys renda indicate that palms were a major structural element of campus vegetation. This dominance suggests that palm species are widely utilized in campus planting schemes, likely due to their ornamental value, adaptability, and suitability for managed green spaces.

In contrast, Dicotyledonae exhibited greater taxonomic diversity across multiple families, including Euphorbiaceae, Apocynaceae, Anacardiaceae, Rubiaceae, Combretaceae, and Acanthaceae. This pattern indicates that although monocots—especially palms—were visually dominant, dicots contributed more broadly to overall species richness and family-level diversity. Several dicot species also reflected multiple functional roles, including ornamental plants such as Ruellia simplex and Euphorbia milii, shade trees such as Terminalia catappa and Polyalthia longifolia, and fruit-bearing plants such as Mangifera indica, Persea americana, and Anacardium occidentale.

A comparison between the two sites further shows that Campus 3 had higher species richness than Campus 1. Campus 1 contained 15 recorded species, whereas Campus 3 contained 18 species. This suggests that Campus 3 supported a more diverse vegetation composition, possibly reflecting differences in vegetation management, planting design, and land-use function. In general, the results demonstrate that the university campus ecosystem functions as a semi-managed habitat dominated by Angiosperms, with palms as the most prominent family and Gymnosperms occurring only in small numbers.

DISCUSSION

The present study demonstrates that university campuses, as semi-managed ecosystems, can support substantial plant diversity and should not be treated merely as ornamental landscapes or passive green infrastructure. The inventory of 33 Spermatophyta species across two campus sites indicates that campus environments can function as ecologically meaningful green spaces even under urban or peri-urban pressure. This finding supports previous work showing that university campuses may serve as important reservoirs of urban biodiversity, particularly where surrounding landscapes are increasingly fragmented by development and infrastructure expansion (Wang et al., 2021; Winkler et al., 2022; Susilowati et al., 2021). However, the significance of the present findings lies not only in the number of species recorded, but also in what this diversity reveals about vegetation management, taxonomic structure, and the ecological multifunctionality of campus landscapes.

A key result of this study is the strong dominance of Angiosperms over Gymnosperms. This pattern is broadly consistent with floristic inventories from urban and semi-natural landscapes, where Angiosperms typically constitute the overwhelming majority of species due to their extensive adaptive radiation, reproductive versatility, and functional diversity (Khan et al., 2021; Lahoti et al., 2020; Kimpouni et al., 2023). In that sense, the present study confirms a well-established macroecological pattern at the campus scale. Yet, this also raises an important interpretive point: the dominance of Angiosperms in managed campus landscapes is not merely a reflection of natural ecological processes, but also of deliberate human selection. Landscape planning in educational institutions often favors flowering plants, fruit trees, ornamental shrubs, and shade trees because they combine visual appeal with practical functions. Consequently, the floristic composition observed here is likely shaped by a dual process involving both ecological suitability and anthropogenic preference. This makes campus vegetation a hybrid system, where biodiversity patterns cannot be interpreted solely through natural community assembly, but must also be read through the lens of management history and institutional landscaping priorities.

The taxonomic distribution between Monocotyledonae and Dicotyledonae further reinforces this interpretation. Monocots were represented mainly by Arecaceae and Asparagaceae, whereas dicots were more taxonomically diverse, particularly across Euphorbiaceae, Apocynaceae, Myrtaceae, and Sapindaceae. This distribution is ecologically meaningful. Monocots, especially Arecaceae, are widely used in tropical urban design because they provide strong structural and aesthetic effects while requiring relatively predictable maintenance (Votsi et al 2024). Their prominence in campus settings therefore suggests a landscaping strategy oriented toward visual order, spatial framing, and architectural harmony. By contrast, the greater diversity of dicots suggests a wider array of ecological and utilitarian roles, including fruit production, medicinal use, shade provision, and habitat support. Similar patterns have been reported in tropical floras, where dicots contribute disproportionately to species richness and structural heterogeneity, whereas monocots often dominate specific life forms or functional niches (Gomes-da-Silva et al., 2021; Gomes-da-Silva et al., 2025). Thus, the campus flora documented in this study reflects not only taxonomic variation, but also differentiated ecological functions embedded within the managed landscape.

The higher species richness recorded in Campus 3 compared with Campus 1 is one of the most important comparative findings of this study. At face value, the result suggests that vegetation richness is associated with differences in landscape management and plant utilization, as stated in the abstract. However, a more critical reading suggests that this difference should not be reduced to a simple comparison of “more” versus “less” diverse sites. Rather, the contrast between the two campuses points to a broader ecological principle: species richness in semi-managed ecosystems is strongly conditioned by management heterogeneity. Landscapes that incorporate multiple vegetation functions, such as ornamental planting, fruit-bearing species, medicinal plants, and shade trees, are more likely to accumulate higher taxonomic diversity than landscapes designed around narrowly aesthetic or highly standardized planting schemes. Studies from urban parks and institutional landscapes likewise show that management intensity, habitat heterogeneity, and land-use history are major determinants of floristic composition and richness (Talal & Santelmann, 2019; Archiciński et al., 2024; Indrawan et al., 2025). From this perspective, the present study provides useful empirical support for the argument that biodiversity in campus landscapes is not incidental, but manageable. Nonetheless, because the present design is descriptive rather than experimentally comparative, the study cannot determine which specific management variables were most responsible for the observed difference. This limits causal interpretation and points to an important area for future research.

The functional composition of the recorded flora provides additional insight into the ecological significance of campus vegetation. The identification of ornamental, fruit-bearing, medicinal, and shade plants indicates that campus green spaces are multifunctional systems rather than single-purpose planting zones. This is a crucial point, because much of the traditional discourse surrounding campus landscapes has emphasized beautification or thermal comfort, while underestimating their broader ecological and educational value. In reality, vegetation with multiple functional roles can simultaneously support microclimate regulation, carbon sequestration, urban habitat provision, educational use, and psychological well-being. Previous research has shown that campus green spaces contribute to carbon storage, stormwater regulation, urban heat mitigation, improved air quality, and culturally valued ecosystem services (Yadav, 2025; Giao & Truong, 2024; Lee et al., 2025; Yerokhin et al., 2024). The present findings align with that literature, but they also extend it by illustrating how multifunctionality can be observed at the species-inventory level. That said, the current study stops short of quantifying the actual magnitude of these ecosystem services. As a result, the discussion of multifunctionality remains inferential rather than empirically measured. This constitutes a notable limitation, since the presence of functionally useful species does not automatically translate into measurable ecological performance.

Another important contribution of this study is its reinforcement of the central role of plant taxonomy in biodiversity research. By classifying plants from kingdom to species level through morphological identification, the study establishes a baseline inventory that can support ecological interpretation, conservation planning, and field-based education. This is methodologically significant because taxonomic clarity is a prerequisite for any meaningful biodiversity assessment (Borsch et al., 2020; Victor et al., 2024; Marín-Rodulfo et al., 2024). Without accurate species-level documentation, discussions of richness, distribution, and ecological value remain conceptually weak. The current study therefore provides an important starting point for documenting local flora in a campus setting. At the same time, the reliance on morphology alone also reveals a methodological gap. Morphological identification is appropriate and often necessary in field-based campus studies, but it may be insufficient for resolving taxonomically difficult groups, cultivated varieties, or closely related ornamental taxa. The absence of herbarium validation, molecular confirmation, or standardized digital taxonomic cross-checking means that some identifications may remain provisional. The taxonomic baseline is valuable, but its robustness would be considerably strengthened by the integration of voucher specimens, herbarium comparison, and DNA-assisted identification where necessary.

From an educational standpoint, the study is particularly relevant because it frames campus vegetation as a resource for field-based learning in plant taxonomy and ecology. This is an important strength, especially in higher education contexts where the gap between classroom theory and field experience remains substantial. A campus with documented flora can function as a living laboratory, enabling repeated observation, taxonomic training, and context-based ecological learning. This aligns with broader pedagogical arguments that authentic learning environments improve conceptual understanding and observational competence (Susilowati et al., 2021; Victor et al., 2024). However, the educational implications of the study are still largely prospective rather than demonstrated. The study argues that the flora can support biology education, but it does not evaluate how students actually use this diversity, whether field-based taxonomy improves learning outcomes, or how the campus landscape might be systematically integrated into curriculum design. In other words, the educational relevance is plausible and important, but it remains an assumed benefit rather than an empirically tested outcome. This reveals another gap in the literature: while many studies identify campuses as ecological resources, far fewer assess how biodiversity inventories are translated into measurable pedagogical practice.

In the context of urban biodiversity conservation, the findings are also noteworthy because they support the idea that campuses can function as microhabitats within broader urban ecological networks. This is particularly important in regions where natural habitats are increasingly reduced and fragmented. The vegetation recorded in this study suggests that campuses may contribute to ex situ conservation, local habitat continuity, and small-scale biodiversity retention. Previous studies have similarly described university campuses as biodiversity hotspots with conservation value in urban settings (Wang et al., 2021; Susilowati et al., 2021; Winkler et al., 2022). Yet, the present study also exposes a recurring limitation in campus biodiversity research: conservation significance is often inferred from species presence alone, without a deeper evaluation of species origin, nativeness, invasiveness, conservation status, or long-term persistence. The current inventory identifies taxonomic composition, but does not distinguish between native and exotic species, rare and common taxa, or threatened and non-threatened elements. This matters because a species-rich campus flora is not necessarily conservation-rich in a strict ecological sense. A landscape dominated by ornamental exotics may appear diverse but may contribute differently to local ecological integrity than one dominated by native taxa. Therefore, the conservation value of campus vegetation should be interpreted cautiously unless supported by more detailed biogeographic and status-based analysis.

Taken together, these points reveal the main research gap addressed by the present study, as well as the gaps that remain unresolved. The study fills an important local gap by documenting 33 Spermatophyta species in two campus sites and by showing that campus vegetation reflects both taxonomic structure and functional heterogeneity. This is valuable because many campus landscapes, particularly in developing or under-documented regions, remain poorly inventoried despite their ecological and educational potential. However, the study also leaves several critical analytical gaps. First, it does not incorporate quantitative diversity metrics such as Shannon, Simpson, evenness, or beta-diversity indices, limiting the strength of ecological comparison between sites. Second, it does not include spatial analysis, which would be essential for understanding how plant distribution relates to habitat configuration, management zones, or microenvironmental gradients. Third, it lacks a native–exotic or invasive species assessment, which constrains interpretation of conservation value. Fourth, it does not measure ecosystem functions directly, even though multifunctionality is a central interpretive theme. Fifth, the educational implications are proposed but not empirically tested. These unresolved issues are not weaknesses that invalidate the study; rather, they define the next generation of research needed to move from descriptive inventory toward integrated ecological, conservation, and pedagogical assessment.

Overall, this study makes a meaningful contribution by demonstrating that university campuses are not ecologically trivial spaces. Instead, they are dynamic semi-managed systems in which biodiversity, institutional planning, and educational opportunity intersect. The inventory of 33 Spermatophyta species, the dominance of Angiosperms, the differences in richness between campuses, and the diversity of plant functions collectively indicate that campus green spaces deserve greater attention in urban biodiversity research. At the same time, a more critical interpretation shows that the true significance of campus vegetation lies not only in its species count, but in how that diversity is structured, managed, valued, and mobilized. For this reason, future studies should move beyond descriptive inventories and adopt more integrative frameworks that combine floristics, functional ecology, spatial analysis, conservation assessment, and educational evaluation. Only through such a multi-dimensional approach can the full ecological and pedagogical significance of campus landscapes be properly understood.

CONCLUSION

University campus ecosystems exhibit a relatively high diversity of Spermatophyta, characterized by the dominance of angiosperms and a relatively limited presence of gymnosperms. Monocotyledonous plants, particularly from the family Arecaceae, play an important role in shaping the structural composition of vegetation, whereas dicotyledonous plants contribute greater species diversity, especially from families such as Euphorbiaceae, Apocynaceae, and Myrtaceae. Differences in plant composition among campus locations indicate the influence of vegetation management practices, planting patterns, and functional uses of plant species. In general, campus vegetation serves not only ecological functions but also provides aesthetic, economic, and educational value. The presence of ornamental, fruit-bearing, and medicinal plants further highlights the role of campuses as green spaces that support biodiversity. Future studies could be strengthened through the application of biodiversity indices, spatial analysis approaches, molecular identification techniques, and long-term ecological monitoring.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the financial support provided by the Institute for Research and Community Service (LPPM), Universitas Muhammadiyah Metro, for the implementation of this study. The authors also extend their sincere appreciation to all individuals and parties who contributed to the data collection and the completion of this research.

REFERENCES

1. Aneklaphakij, C., Bunsupa, S., Sirichamorn, Y., Bongcheewin, B., & Satitpatipan, V. (2020). Taxonomic Notes on the ‘Mahat’ (Artocarpus lacucha and A. thailandicus, Moraceae) Species Complex in Thailand. Plants, 9(3), 391. https://doi.org/10.3390/plants9030391
2. Arjona, J., Ibáñez-Álamo, J., & Sanllorente, O. (2023). Mediterranean university campuses enhance butterfly (Lepidoptera) and beetle (Coleoptera) diversity. Frontiers in Ecology and Evolution, 11. https://doi.org/10.3389/fevo.2023.1130557
3. Borsch, T., Berendsohn, W., Dalcin, E., Delmas, M., Demissew, S., Elliott, A., … & Zamora, N. (2020). World Flora Online: Placing taxonomists at the heart of a definitive and comprehensive global resource on the world's plants. Taxon, 69(6), 1311-1341. https://doi.org/10.1002/tax.12373

4. Deng, M., Lin, L., Liu, L., Huang, S., Tu, Y., Lu, Z., … & Huang, J. (2024). Quercus zhekunii M.Deng & J.Huang, a new sclerophyllous oak from Guangxi, southwest China. Nordic Journal of Botany, 2025(6). https://doi.org/10.1111/njb.04512
5. Gallagher, R., Allen, S., Govaerts, R., Rivers, M., Allen, A., Keith, D., Adams, V. (2023). Global shortfalls in threat assessments for endemic flora by country. Plants People Planet, 5(6), 885-898. https://doi.org/10.1002/ppp3.10369
6. Giao, N. and Truong, D. (2024). Evaluating the Importance of Ecosystem Services in University Campus. Civil Engineering Journal, 10(1), 234-248. https://doi.org/10.28991/cej-2024-010-01-015
7. Gomes-da-Silva, J., Lughadha, E., & Forzza, R. (2025). Protecting hidden treasures: Indigenous lands safeguard 50% of areas with the highest potential for angiosperm discoveries in Brazil—patterns and conservation priorities. Plos One, 20(7), e0326507. https://doi.org/10.1371/journal.pone.0326507
8. Greene, A., Teixidor-Toneu, I., & Odonne, G. (2023). To Pick or Not to Pick: Photographic Voucher Specimens as an Alternative Method to Botanical Collecting in Ethnobotany. Journal of Ethnobiology, 43(1), 44-56. https://doi.org/10.1177/02780771231162190
9. Gristina, E., Barone, G., Domina, G., Badalamenti, E., Gargano, M., Venturella, G., Pardi, R. (2025). A Checklist of the Ornamental Vascular Flora of Sicily. Plants, 14(5), 795. https://doi.org/10.3390/plants14050795
10. Hasan, R., Yeo, L., Othmani, N., Mohamed, S., Awang, A., & Aziz, N. (2023). Improving Campus Sustainability and Resilience by Selecting Climate - Appropriate Plants. Bio Web of Conferences, 73, 03006. https://doi.org/10.1051/bioconf/20237303006
11. Hochkirch, A., Samways, M., Gerlach, J., Böhm, M., Williams, P., Cardoso, P., … & Dijkstra, K. (2020). A strategy for the next decade to address data deficiency in neglected biodiversity. Conservation Biology, 35(2), 502-509. https://doi.org/10.1111/cobi.13589
12. Indrawan, M., Setyawan, A., Nazar, I., Sunarto, S., Wahyuni, T., Himawan, W., … & Chairunisa, S. (2025). Tree Community at the GOS of 45 Banjarsari Monument and the GOS of TMP, Surakarta, Central Java. Iop Conference Series Earth and Environmental Science, 1438(1), 012062. https://doi.org/10.1088/1755-1315/1438/1/012062
13. Khan, S., Sultana, S., Hossain, G., Shetu, S., & Rahim, A. (2021). Floristic composition of Jahangirnagar University Campus - A semi-natural area of Bangladesh. Bangladesh Journal of Plant Taxonomy, 28(1), 27-60. https://doi.org/10.3329/bjpt.v28i1.54207
14. Kimpouni, V., Ghislain, B., Chaîph, M., Piccard, M., & Charmes-Maïdet, M. (2023). Floristic Diversity of the Trees of Street Alignment and Concern of the Populations in Brazzaville. AFF. https://doi.org/10.11648/j.aff.20231203.12
15. Lahoti, S., Lahoti, A., Joshi, R., & Saitô, O. (2020). Vegetation Structure, Species Composition, and Carbon Sink Potential of Urban Green Spaces in Nagpur City, India. Land, 9(4), 107. https://doi.org/10.3390/land9040107
16. Lee, S., Park, W., Lee, S., Lee, J., Son, Y., & Yoon, T. (2025). Tree mapping and carbon inventory on a university campus in South Korea: Case study and global review. Ecosphere, 16(1). https://doi.org/10.1002/ecs2.70118
17. Liang, C., Liu, J., Pan, B., Wang, N., Yang, J., Gui-sheng, Y., … & Feng, G. (2020). Precipitation is the dominant driver for bird species richness, phylogenetic and functional structure in university campuses in northern China. Avian Research, 11(1). https://doi.org/10.1186/s40657-020-00212-x
18. Marín-Rodulfo, M., Rondinel-Mendoza, K., Girela, I., Cañadas, E., & Lorite, J. (2024). Old meets new: Innovative and evolving uses of herbaria over time as revealed by a literature review. Plants People Planet, 6(6), 1261-1271. https://doi.org/10.1002/ppp3.10541
19. Rehem, B., Dantas, M., Nascimento, S., Freitas, E., Silva, L., & Paixão, J. (2020). Native And Exotic Species of Economically Used Plants in The Southern Bahia Atlantic Forest Region. Brazilian Journal of Development, 6(8), 59417-59432. https://doi.org/10.34117/bjdv6n8-384
20. Serret, H., Andersen, D., Deguines, N., Clauzel, C., Park, W., & Jang, Y. (2022). Towards Ecological Management and Sustainable Urban Planning in Seoul, South Korea: Mapping Wild Pollinator Habitat Preferences and Corridors Using Citizen Science Data. Animals, 12(11), 1469. https://doi.org/10.3390/ani12111469
21. Singh, R., Tiwari, A., Kumar, S., & Singh, G. (2024). Avifaunal Diversity in Managed Urban Ecosystem: A Case Study of Banaras Hindu University, Varanasi. Ecological Questions, 35(3), 1-25.

https://doi.org/10.12775/eq.2024.038

22. Singh, S., Singh, B., Surmal, O., Bhat, M., Singh, B., & Musarella, C. (2021). Fragmented Forest Patches in the Indian Himalayas Preserve Unique Components of Biodiversity: Investigation of the Floristic Composition nd Phytoclimate of the Unexplored Bani Valley. Sustainability, 13(11), 6063. https://doi.org/10.3390/su13116063
23. Susilowati, A., Rangkuti, A., Rachmat, H., Iswanto, A., Harahap, M., Elfiati, D., Ginting, I. (2021). Maintaining tree biodiversity in urban communities on the university campus. Biodiversitas Journal of Biological Diversity, 22(5). https://doi.org/10.13057/biodiv/d220548
24. Talal, M. and Santelmann, M. (2019). Plant Community Composition and Biodiversity Patterns in Urban Parks of Portland, Oregon. Frontiers in Ecology and Evolution, 7. https://doi.org/10.3389/fevo.2019.00201
25. Ullah, F., Gao, Y., Jiao, R., & Gao, X. (2021). Comparative taxonomic variation in fruits and seeds' surface morphology among populations of alpine Rosa sericea complex (Rosaceae). Microscopy Research and Technique, 84(10), 2337-2350. https://doi.org/10.1002/jemt.23788
26. Vázquez-Ramírez, J. (2025). Unexpected consequences of taxonomic misidentification for the conservation of an endangered species. Conservation Science and Practice, 7(12). https://doi.org/10.1111/csp2.70180
27. Victor, J., Klopper, R., Winter, P., & Roux, M. (2024). The plant checklist: Building the foundation of botanical knowledge in South Africa. Taxon, 73(4), 943-948. https://doi.org/10.1002/tax.13169
28. Villaseñor, J. and Meave, J. (2022). Floristics in Mexico today: insights into a better understanding of biodiversity in a megadiverse country. Botanical Sciences, 100(Special), S14-S33. https://doi.org/10.17129/botsci.3050
29. Votsi, N., Speyer, O., Michailidou, D., Koukoulis, A., Chatzidiakos, C., Vandecasteele, I Gerasopoulos, E. (2024). Urban Biodiversity Index for Trees: A Climate Adaptation Measure for Cities Based on Tree Inventories. Environments, 11(7), 144. https://doi.org/10.3390/environments11070144
30. Vourlitis, G., Veen, E., Cangahuala, S., Jaeger, G., Jensen, C., Fissore, C.& Meyer, W. (2022). Examining Decomposition and Nitrogen Mineralization in Five Common Urban Habitat Types across Southern California to Inform Sustainable Landscaping. Urban Science, 6(3), 61. https://doi.org/10.3390/urbansci6030061
31. Wang, X., Liu, J., Liang, C., Zhao, Z., Feng, G., & Zhang, J. (2021). Biodiversity dataset of vascular plants and birds in Chinese urban greenspace. Ecological Research, 36(4), 755-761. https://doi.org/10.1111/1440-1703.12240
32. Winkler, J., Jeznach, J., Koda, E., Sas, W., Mazur, Ł., & Vaverková, M. (2022). Promoting Biodiversity: Vegetation in a Model Small Park Located in the Research and Educational Centre. Journal of Ecological Engineering, 23(1), 146-157. https://doi.org/10.12911/22998993/143997
33. Yadav, P. (2025). Assessment of Urban Green Space for Optimizing Ecosystem Services Related to Climate Change Adaptation. Environmental Quality Management, 35(2). https://doi.org/10.1002/tqem.70236
34. Yerokhin, S., Feuer, Y., & Sassen, R. (2024). Biodiversity preservation in German higher education institutions: existing approaches, challenges and future developments. International Journal of Sustainability in Higher Education, 26(4), 717-734. https://doi.org/10.1108/ijshe-12-2023-0608
35. Zaman, W., Lee, E., & Park, S. (2024). Endemic species analysis: Foliar epidermal anatomical characters of Aster glehnii F. Schmidt (Asteraceae). Microscopy Research and Technique, 87(7), 1640-1646. https://doi.org/10.1002/jemt.24547
36. Zhu, Z., Harris, A., Nizamani, M., Thornhill, A., Scherson, R., & Wang, H. (2021). Spatial phylogenetics of the native woody plant species in Hainan, China. Ecology and Evolution, 11(5), 2100-2109. https://doi.org/10.1002/ece3.7180
37. Muggia, L., Pérez-Ortega, S., Fryday, A., Spribille, T. & Grube, M. 2013. Global assessment of genetic variation and phenotypic plasticity in the lichen-forming species Tephromela atra. Fungal Diversity 64: 233–251. https://doi.org/10.1007/s13225-013-0271-4
38. Muñoz, J., Felicísimo, Á. M., Cabezas, F., Burgaz, A. R. & Martínez, I. 2004. Wind as a long-distance dispersal vehicle in the Southern Hemisphere. Science 304: 1144–1147. https://doi.org/10.1126/science.1095210
39. Naciri, Y. & Linder, H. P. 2015. Species delimitation and relation-ships: The dance of the seven veils.

Taxon 64: 3–16. https://doi. org/10.12705/641.24
40. Naciri, Y. & Linder, H. P. 2020. The genetics of evolutionary radia-tions. Biological Reviews 95: 1055–1072. https://doi.org/10.1111/ brv.12598
41. Nadel, M. R. A. & Clerc, P. 2022. Notes on the genus Usnea Adans. (lichenized Ascomycota, Parmeliaceae) from the islands of São Tomé and Príncipe in tropical West Africa. The Lichenologist 54: 271–289. https://doi.org/10.1017/S0024282922000238
42. Nayaka, S., Upreti, D. K. & Bajpai, R. 2009. Diversity and adaptive response of lichens in Antarctica. In: Sridhar, K. R. (ed.), Frontiers in fungal ecology, diversity and metabolites, pp. 107–123. IK International Publishing House Pvt. Ltd, New Delhi, India.
43. Nishimura, D. 2000. Sequence Analysis Star. Science 287: 453–454. Ohmura, Y. 2001. Taxonomic study of the genus Usnea (lichenized Ascomycetes) in Japan and Taiwan. Journal of the Hattori Botanical Laboratory 90: 1–96.
44. Ohmura, Y. 2012. A synopsis of the lichen genus Usnea (Parmeliaceae, Ascomycota) in Taiwan. Memoirs of the National Museum of Nature and Science 48: 91–137.
45. Ohmura, Y. 2014. Usnea flavocardia (Parmeliaceae, lichenized Asco-mycota) new to Asia. Bulletin of the National Museum of Nature and Science 40: 69–72.
46. Otálora, M. A., Jørgensen, P. M. & Wedin, M. 2014. A revised generic classification of the jelly lichens, Collemataceae. Fungal Diversity 64: 275–293. https://doi.org/10.1007/s13225-013-0266-1
47. Penn, O., Privman, E., Ashkenazy, H., Landan, G., Graur, D. & Pupko, T. 2010. GUIDANCE: a web server for assessing alignment confi-dence scores. Nucleic Acids Research 38: W23–W28. https://doi.org/10.1093/nar/gkq443
48. Pérez-Ortega, S., Fernández-Mendoza, Raggio, F. J., Vivas, M. & As-caso, C. 2012. Extreme phenotypic variation in Cetraria aculeata (lichenized Ascomycota): adaptation or incidental modification? An-nals of Botany 109: 1133–1148. https://doi.org/10.1093/aob/mcs042
49. Pintado, A., Valladares, F. & Sancho, L. G. 1997. Exploring pheno-typic plasticity in the lichen Ramalina capitata: morphology, water relations and chlorophyll content in north- and south-facing pop-ulations. Annals of Botany 80: 345–353. https://doi.org/10.1006/ anbo.1997.0453
50. Printzen, C. 2009. Lichen Systematics: The role of morphological and molecular data to reconstruct phylogenetic relationships. In: Lüttge, U. et al. (eds), Progress in Botany 71, pp. 233–275. Springer-Verlag, Berlin, Heidelberg 2010. https://doi.org/10.1007/978-3-642-02167-1_10
51. Rambaut, A. 2017. FigTree-version 1.4.3, a graphical viewer of phylo-genetic trees. Computer program distributed by the author, website: http://tree.bio.ed.ac.uk/software/figtree
52. Rambaut, A., Drummond, A. J., Xie, D., Baele, G. & Suchard, M. A. 2018. Posterior summarization in Bayesian phylogenetics using Tracer 1.7. Systematic Biology 67: 901–904. https://doi.org/10.1093/sysbio/syy032
53. Räsänen, V. 1936. Collationes ad lichenologiam Chilensem pertinentes. Revista Universitaria 21: 137–148.
54. Rodriguez, J. M., Estrabou, C., Truong, C. & Clerc, P. 2011. The saxic-olous species of the genus Usnea subgenus Usnea (Parmeliaceae) in Argentina and Uruguay. The Bryologist 114: 504–525. https://doi.org/10.1639/0007-2745-114.3.504
55. Rosenberg, N. A. 2003. The shape of neutral gene genealogies in two species: probabilities o monophyly, paraphyly, and polyphyly in a coalescent model. Evolution 57: 1465–1477. https://doi.org/10.1111/j.0014-3820.2003.tb00355.x
56. Rundel, P. W. 1978. Ecological relationships of desert fog zone lichens. The Bryologist 81: 277–293. https://doi.org/10.2307/3242189
57. Saag, L., Tõrra, T., Saag, A., Del-Prado, R. & Randlane, T. 2011. Phylogenetic relations of European shrubby taxa of the genus Usnea. The Lichenologist 43: 427–444. https://doi.org/10.1017/S0024282911000375
58. Spribille, T., Resl, P., Ahti, T., Pérez-Ortega, S., Tønsberg, T., Mayrhofer, H. & Lumbsch, H. T. 2014. Molecular systematics of the wood-inhabiting, lichen-forming genus Xylographa (Baeomyce-tales, Ostropomycetidae) with eight new species. Acta Universitatis Upsaliensis. Symbolae botanicae Upsalienses 37: 1–87.
59. Stevens, G. N. 1999. A revision of the lichen family Usneaceae in Australia. Bibliotheca Lichenologica 72: 1–128.

60. Swinscow, T. D. V. & Krog, H. 1978. Pendulous species of Usnea in East Africa. Norwegian Journal of Botany 25: 221–241. https:// doi.org/10.1017/S0024282911000375
61. Truong, C. & Clerc, P. 2012. The lichen genus Usnea (Parmeliaceae) in tropical South America: species with a pigmented medulla, reacting C+ yellow. The Lichenologist 44: 625–637. https://doi.org/10.1017/S0024282912000400
62. Truong, C. & Clerc, P. 2013. Eumitrioid Usnea species (Parmelia-ceae, lichenized Ascomycota) in tropical South America and the Galapagos. The Lichenologist 45: 83–395. https://doi.org/10.1017/S0024282912000904
63. Truong, C. & Clerc, P. 2016. New species and new records in the genus Usnea (Parmeliaceae, lichenized Ascomycota) from tropical South America. The Lichenologist 48: 71–93. https://doi.org/10.1017/ S0024282915000419
64. Truong, C., Bungartz, F. & Clerc, P. 2011. The lichen genus Usnea (Parmeliaceae) in the tropical Andes and the Galapagos: species with a red-orange cortical or subcortical pigmentation. The Bryologist 114: 477–503. https://doi.org/10.1639/0007-2745-114.3.477
65. Truong, C., Divakar, P. K., Yahr, R., Crespo, A. & Clerc, P. 2013a. Test-ing the use of ITS rDNA and protein-coding genes in the generic and species delimitation of the lichen genus Usnea (Parmeliaceae, Ascomycota). Molecular Phylogenetics and Evolution 68: 357–372. https://doi.org/10.1016/j.ympev.2013.04.005
66. Truong, C, Rodriguez, J. M. & Clerc, P. 2013b. Pendulous Usnea species (Parmeliaceae, lichenized Ascomycota) in tropical South America and the Galapagos. The Lichenologist 45: 505–543. https://doi. org/10.1017/S0024282913000133
67. Vondrák, J., Soun, Y., Søgaard, M. Z., Søchting, U. & Arup, U. 2010. Caloplaca phlogina, a lichen with two facies; an example of in-fraspecific variability resulting in the description of a redundant species. The Lichenologist 42: 685–692. https://doi.org/10.1017/ S0024282910000435
68. Walter, F. J. 1985. The lichen genus Usnea subgenus Neuropogon. Bulletin of the British Museum (Natural History), Botany series 13: 1–130.
69. Wirtz, N., Printzen, C., Sancho, L. G. & Lumbsch, H. T. 2006. The phylogeny and classification of Neuropogon and Usnea (Parme-liaceae, Ascomycota) revisited. Taxon 55: 367–376. https://doi.org/10.2307/25065584
70. Yang, Z. & Rannala, B. 2010. Bayesian species delimitation using multilocus sequence data. Proceedings of the National Academy of Sciences 107: 9264–9269. https://doi.org/10.1073/pnas.0913022107
71. Zhao, X., Leavitt, S. D., Zhao, Z. T., Zhang, L. L., Arup, U., Grube, M. & Lumbsch, H. T. 2016. Towards a revised generic classification of lecanoroid lichens (Lecanoraceae, Ascomycota) based on molec-ular, morphological and chemical evidence. Fungal Diversity 78: 293–304. https://doi.org/10.1007/s13225-015-0354-5
72. Zolan, M. E. & Pukkila, P. J. 1986. Inheritance of DNA methylation in Coprinus cinereus. Molecular and Cellular Biology 6: 195–200. https://doi.org/10.1128/mcb.6.1.195-200.1986