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# Biodiversity Database Digitalize Character Spot as an Interactive Tool for Plant Identification Study

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**Abstract**

*Plant biodiversity information is one of the main sources of data in botany and conservation research. Difficulties in identifying plants using dichotomous key in identification process can be assisted by using the morphological spot characters approach. The collection of morphological spot characters of plants was carried out by exploring the pavement areas and experimental gardens in SEAMEO BIOTROP, the spot characters were digitizing and layouts using Canva Pro. The results of the exploration were obtained 143 species, 119 genus and 45 families, the biodiversity dendrogram of the species was generated R Studio by the package V.PhyloMaker2. The spot characters information is then input into the biodiversity database developed at SEAMEO BIOTROP. Databases of spot characters can be used as a tool in learning plant morphology and can help the process of plant identification.*

**Keywords:** biodiversity database, plant morphology, spot character.

## Introduction

Plant taxonomy plays a significant role in biodiversity research and conservation activities. It involves the identification, naming, description, and classification of plants. The primary objective of plant taxonomy is to understand plant characteristics, clearly distinguish between species, and organize this information within a coherent system. This discipline is often referred to as plant systematics (Walters & Keil, 1988). Despite its importance, interest in botany has declined over the past century, even as global environmental challenges such as biodiversity loss and climate change have become increasingly urgent (Kletecki et al., 2023).

The declining interest in studying botany has contributed to a reduced appreciation for plants (Bromme *et al.,* 2004). Nowadays, this phenomenon commonly referred to as "plant blindness," is defined as the inability to notice or organize the plants in one's environment, to understand their ecological significance, to appreciate their aesthetic and unique biological features of the life forms, and a tendency to rank plants as inferior to animals due to anthropocentric worldview. Thus, plants are often regarded as unworthy of consideration, and their essential roles withing ecosystems are overlooked (Gubo, V. & Schiffl 2022; Wandersee & Schussler, 1999). In order to mitigate the effects of "plant blindness", one effective strategy is by enhancing public knowledge and motivation in studying the plants, which can be facilitated through the development of digital plant identification tools (Finger *et al.,* 2022). The process of plant identification can be challenging and intimidating, particularly for beginners, as many people find the use of traditional dichotomous keys in the identification process difficult. To address this, emphasizing the observation of morphological characteristics can assist in identifying plants more accessible (Mangold, 2018). Through technological advancements, the process of plant identification has developed rapidly with a variety of mobile

applications, such as PlantNet, PlantSnap, LeafSnap, iNaturalist Seek and Google Lens, demonstrating high level of user satisfaction and very useful in identifying up to the species level (Hart *et al.,* 2023).

SEAMEO BIOTROP has become a partner of Kampus Merdeka (MBKM), a program under the Merdeka Belajar policy by the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia. The Tropical Biodiversity Management (TBM) Division is one of the programs offered through MBKM in collaboration with SEAMEO BIOTROP. These programs combine class sessions with fieldwork activities, including plant identification. The objective of this study is to introduce plant classification, focusing on weeds, through an interactive learning process that involves recognizing key characteristics for plant identification and digitizing plant specimens to develop a comprehensive database.

## Methods

### Sampel collections

The plant samples were obtained through exploration and purposive sampling. Most of the collected plants were weeds found in the pavement areas around the main office and the experimental field of SEAMEO BIOTROP. This study involved 15 students who took the Tropical Biodiversity Management (TBM) Division. Each student was required to collect at least 10 plants, ensuring no duplication among participants. Fresh plant material was collected using pruning shears and stored in plastics bag. The samples included both vegetative and generative parts for accurate identification. Collected specimens were brought to the herbarium for processing into herbarium specimens and for digital documentation of spot characters.

### Spot character identification process

Plant identification was conducted using spot character methodology, focusing on the basic morphological features such as leaves, stem, and inflorescence. The main collected samples were weeds. The classification of the samples was divided into three main groups: broadleaves, grasses, and sedges. Species-level identification was performed using plant identification mobile applications (PlantNet, PlantSnap, and Google Lens) and was asked the expert for further confirmation. The identification results were verified using book reference, including the *Weed of Rice of Indonesia*, the *Global Biodiversity Information Facility (GBIF) Portal* and herbarium specimens in SEAMEO BIOTROP Herbarium (BIOT).

### Digitalization process

Fresh samples collected from the field should be digitalized before wilting occurs. The digitalization of the samples used a Canon scanner and Nikon DSLR cameras (Nikon D7200 and Nikon Z series) to produce high-resolution image. Samples were cut when necessary for the digitalization process. Each part of the plant was carefully arranged and placed on a scale during scanning or photography to maintain accurate details. To arrange the plant characters, Canva Pro was used to remove image backgrounds and organize the spot characters of the sample onto a single page.

### Dendrogram of the species

Plant phylogenetic tree for the species pool constructing by using megatree of vascular plants in R Package V.PhyloMaker2 (Jin & Qian, 2022). R script for using V.PhyloMaker2 to generate a phylogenetic tree for the species in 'sample_species_list.csv' based on GBOTB.extended.TPL.tre, nodes.info.1.TPL, and scenario 3 (i.e. S3).

```
# load the package
library("V.PhyloMaker2") # input the
sample species list example <-
read.csv("sample_species_list.csv") #
generate a phylogeny for the sample species
list tree <- phylo.maker(sp.list ¼ example,
tree ¼ GBOTB.extended.TPL, nodes ¼
nodes.info.1.TPL, scenarios ¼ "S3")
write.tree(tree$scenario.3, "sample.tre")
```

## Results and Discussion

### Project-Based Learning Design in Tropical Biodiversity Management (TBM)

The Project-based learning design in the Tropical Biodiversity Management (TBM) program involves structured activities to ensure an effective and engaging educational experience for students. In the TBM division, the focus was placed on the management of weeds and Invasive Alien Species (IAS) (see figure 1). The class sessions were designed to provide a deeper understanding of the challenges faced with plant morphology and IAS management. The TBM project-based learning model was developed to integrate the plant invasion concepts into an interesting and interactive context for students.

Weed and IAS serve as compelling examples of "plant blindness," since weeds simply defined as unwanted and unattractive plants perceived to have negative impacts to the environment. Commonly described as "plants in the wrong location," weeds are associated with various ecological, social and economic issues such as soil erosion, pollution, and production costs. However, the definition of weeds also changes as part of ecosystem (Singh *et al.,* 2023). The TBM model was developed to provide students with direct field experience and to build awareness of biodiversity loss and conservation from the field. Students collected and identified weed species in the field and engaged in discussions with field guides. This activity had a significant impact on students by obtaining firsthand experience in identifying IAS along the tracking road and enhancing their understanding of the ecological impacts of plant invasions.

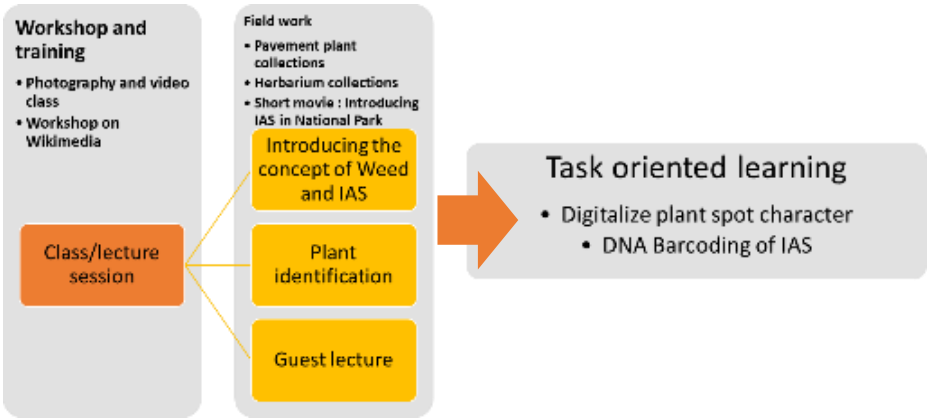


**Figure 1.** Tropical Biodiversity Management learning model in MBKM SEAMEO BIOTROP

**Table 1**. The founding of IAS on the tracking road from basecamp to Cibereum waterfall in Gunung Gede Pangrango National Park

| No. | Species | Family |
|---|---|---|
| 1 | *Cestrum aurantiacum* Lindl. | Solanaceae |
| 2 | *Brugmansia suaveolens* (Humb. & Bonpl. ex Willd.) Bercht. & J.Presl | Solanaceae |
| 3 | *Passiflora ligularis* Juss. | Passifloraceae |
| 4 | *Bartlettina sordida* (Less.) R.M.King & H.Rob. | Asteraceae |
| 5 | *Ageratina riparia* (Regel) R.M.King & H.Rob. | Asteraceae |

## Digitalization spot characters

Plants recognition and identification remain challenging tasks. For experts, identification is relatively straightforward due to their familiarity with key morphological features, for instance groups of medicinal or toxic plants (Nagabhushana & Nataraja, 2018). The digitalization process began by collecting the samples from the field, resulting in a total of 145 species across 46 families and 116 genera. The most abundant families were Asteraceae (25 species), Poaceae (17 species), and Fabaceae (10 species) (see Figure 2). To help beginners build familiarity with plant morphology and spot characters, we developed a standardized workflow for digitizing these key traits (see Figure 5). Utilizing spot characters, such as seed morphology in the Malesian region, has proven effective in simplifying plant identification (Max *et al*., 2015); (Zungsontiporn *et al*., 2020).

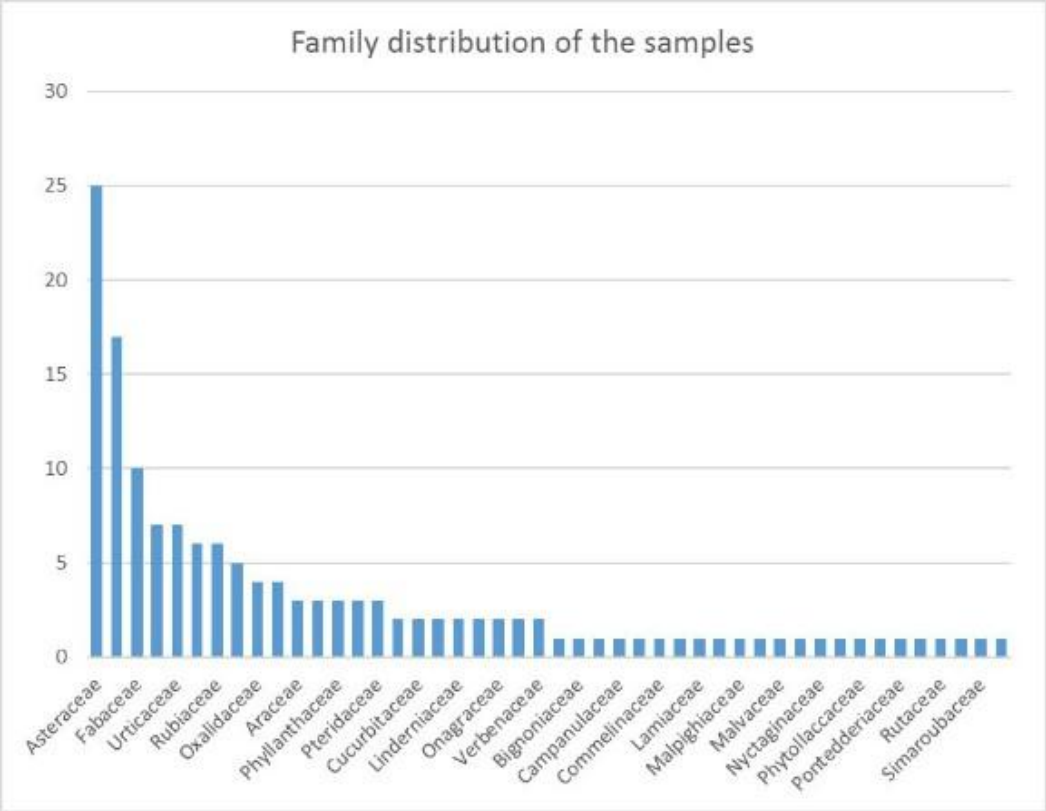


**Figure 2.** Distribution of plant families from pavement areas and the experimental field

Most students collected Asteraceae family, as they are easy to recognize due to their brightly colored flowers and broad leaves. In contrast, grasses or sedges were less frequently collected, in part because mobile identification applications tend to perform better with broadleaved plants than with narrow-leaved species. This limitation contributed to the higher representation of broadleaves in the sample distribution (see Figure 3).

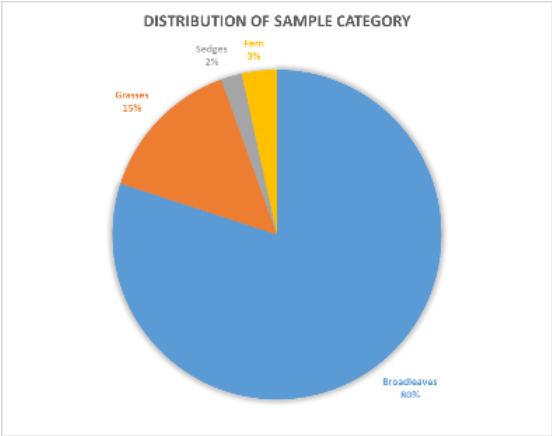


**Figure 3.** Grouping of weed species collected from the field based on spot characters

The digitization of plant spot characters emerged as a key output of the task-oriented learning process. This approach emphasizes completing specific tasks directly related to the skills and knowledge require in a particular profession, which promotes increased engagement and improved skill acquisition (Dai & Nor, 2024). The process began with field collection, followed by categorization of the spot characters based on morphology (see Figure 4). Samples were brought to the herbarium, where they were processed become herbarium specimens and further studied the spot characters of the plants.

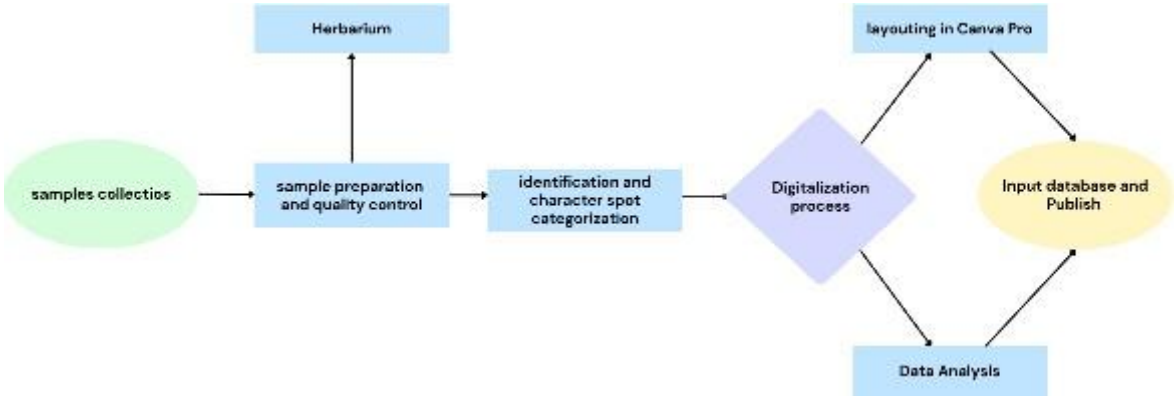


**Figure 4.** Digitalization workflow for building plant spot characters

Since its establishment, SEAMEO BIOTROP has engaged in extensive botanical exploration. At that time, the Tropical Pest Biology Program has conducted numerous studies and exploration on weeds across various regions of Indonesia. These efforts have resulted in a valuable herbarium collection, containing identified specimens along with associated distribution, ecological, and biological data. These collections have been widely distributed through books, leaflets, journal articles, and other publications. Specimen's collection and reference are useful for supporting both students and researcher efforts in plant identification and digitalization.

A herbarium is a collection of preserved plant specimens that serve as a scientific reference. Typically, these specimens are mounted on sheets of paper and stored in controlled environments to ensure long-term preservation. However, physical access to herbarium collections can be restricted due to geographic, conservation, or deterioration-related constraints. To maintain the specimen condition, the BIOT

herbarium has the digitalization of its collection and the development of a comprehensive herbarium database. This digital platform allows users to access specimen images and their associated spot characters remotely.

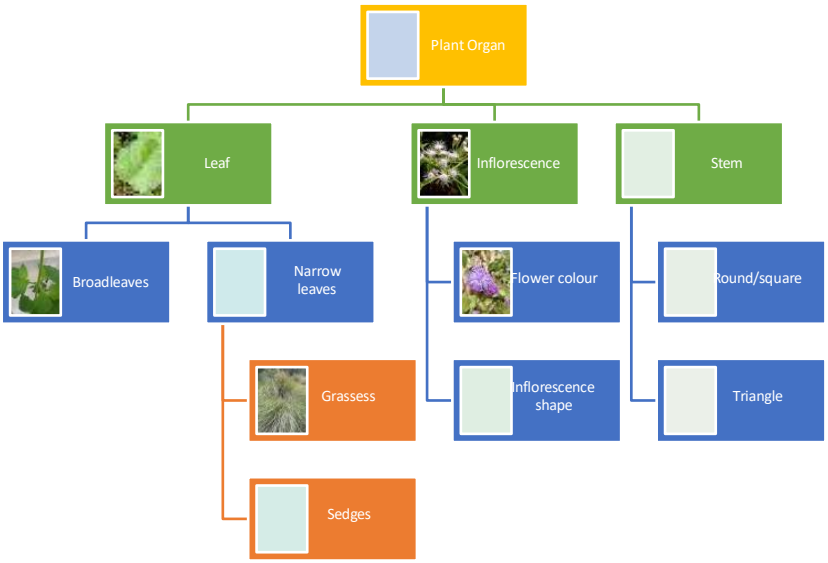


**Figure 5.** Workflow for categorizing plant spot characters.

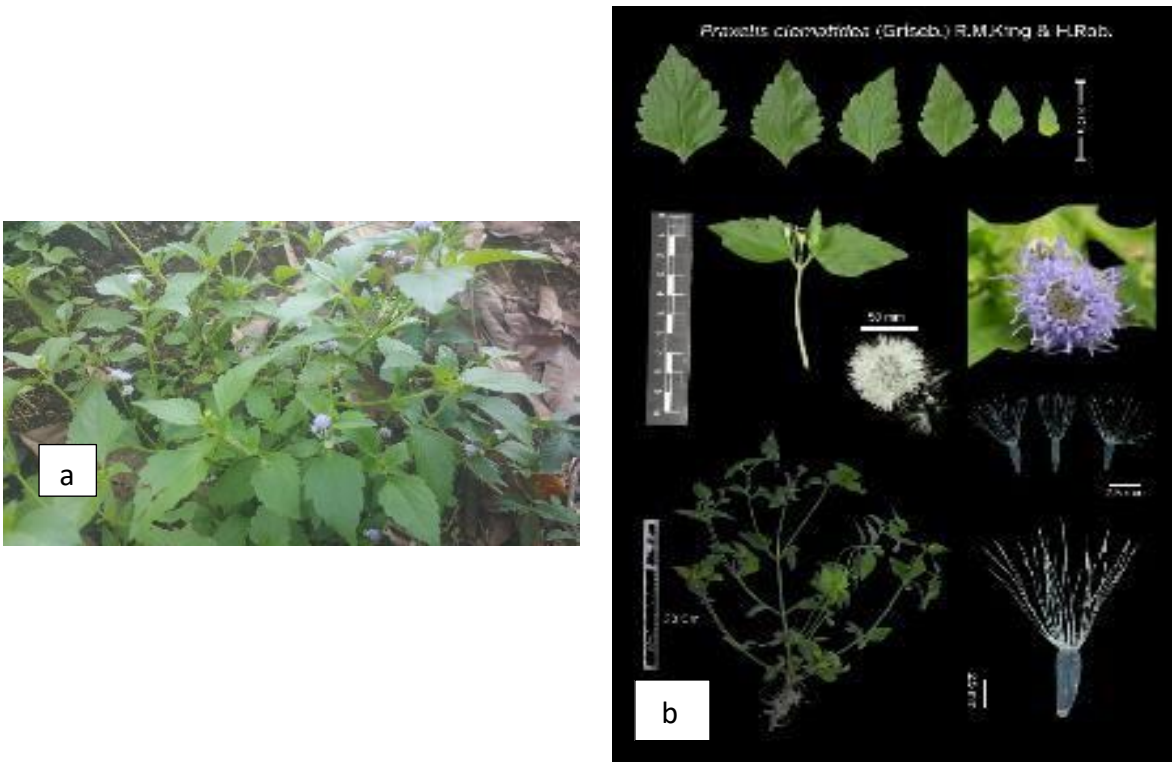


**Figure 6.** *Praxelis clematidea* in the field (a) and digitized spot characters (b)

The digitization of herbarium specimens is a transformative process that involves converting physical plant specimens stored in herbaria into a digital format. The process is conducted to improve accessibility, preservation, and efficiency of research in botany and related fields (Irawan & Eneng, 2023).

The digitalization of plants contributes to the study of spontaneous urban vegetation in the context of urban botany, art-science integration, and

participatory studies that engage with their ecological function (Vega *et al.,* 2021). Spot character digitization actively engages students and fosters awareness of weeds through ecological approach. This approach combines the concept of weeds as ecological components in the ecosystem with a transdisciplinary citizen science project. The resulting digitized spot characters (see Figure 4) can serve as a comprehensible reference for future plant identification.

**Phylogeny Dendrogram**

The digitalization model also provides dynamic learning experience. Visualization and transformation from field to digital format, including the development of the phylogenic tree, helps students better understand plant communities. The phylogeny tree was generated using RStudio and the V.PhyloMaker 2 package, utilizing species names, genera, and families from the collected samples. This process helps to make abstract concepts related to biodiversity and community structure more tangible, allowing students to view plants as integral components of ecosystems. The resulting phylogenetic tree categorized the samples into three main groups: broadleaves, sedges, and grasses

**Conclusion**

Project-based learning is an innovative educational method that has gained wide popularity in recent years. This type of learning takes the learning experience beyond simply transmitting information. Learners delve into realistic problems, questions, and challenges, and work to find solutions themselves, which makes the learning process more realistic and relevant to their lives. It is characterized by its student-centered orientation and its emphasis on real-world applicability.

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