

Developing Virtual Herbarium of Sunan Kalijaga Islamic State University as a Plant Taxonomy Complementary Lab Work Material

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Manuscript received: 29 September, 2023. Revision accepted: 20 December, 2023. Published: 29 January, 2024.

Abstract

This research combines the fields of biology, photography, graphic design, and informatics. This study aims to develop a virtual herbarium museum through website media. The research was done to improve the accessibility and sharing of data (*free access*) herbarium. Website development was performed using the SDLC (*Systems Development Life Cycle*) which consists of 5 (five) steps, namely planning a strategic website development plan, determining the scope of development, analyzing the required needs, designing and implementing website creation and testing. Based on the results of system testing and implementation, it can be concluded that the virtual herbarium museum has been successfully built as a plant taxonomy complementary lab work material.

Keywords: virtual herbarium; online herbarium; baturagung.

INTRODUCTION

Nglanggeran is a remnant of ancient mountain which still retains a wide variety of wild plants. The Nglanggeran site has a potential database of plant remains in the northern Gunung Kidul mountain zone, or what we know as the Baturagung zone.

Herbarium is preserved plant material. The functions of the herbarium include is as a data storage center, documentation, references, research materials, teaching materials for taxonomy lab work, and as reference specimens used for plant identification.

Herbarium has several drawbacks, namely, (1). Poor maintenance or frequent use can cause the specimen to be easily damaged, (2). Not easily accessible by several people together, (3). Only directly accessible or not remotely accessible, (4). Can not be accessed at any time.

Biological research museums have the same mission as libraries, but instead of preserving books, biology collections preserve individual organisms. The collection grows continuously through the activities of faculty, students, and other researchers, as well as by exchanges

with other museums. As they grow, collections increase in value, preserve samples of natural variation, document the occurrence of species in space and time, and provide an important basis for our understanding of species identity. The biology collection is also a source of information regarding phylogenetic (evolutionary) relationships. Without this phylogenetic context, no comparative biology would be possible.

The rapid advancement of information technology makes the accessibility of information exchange easier. The convenience obtained from the development of information technology is important in supporting *research* and scientific activities. One of the advances in information technology is the rapid development of the internet which is a supporting factor in this accessibility. The rapid development of the internet can be seen from the internet user data which is always increasing from year to year (internetworldstats.com, 2024), both globally and in Indonesia. The data is as shown in the following graph:

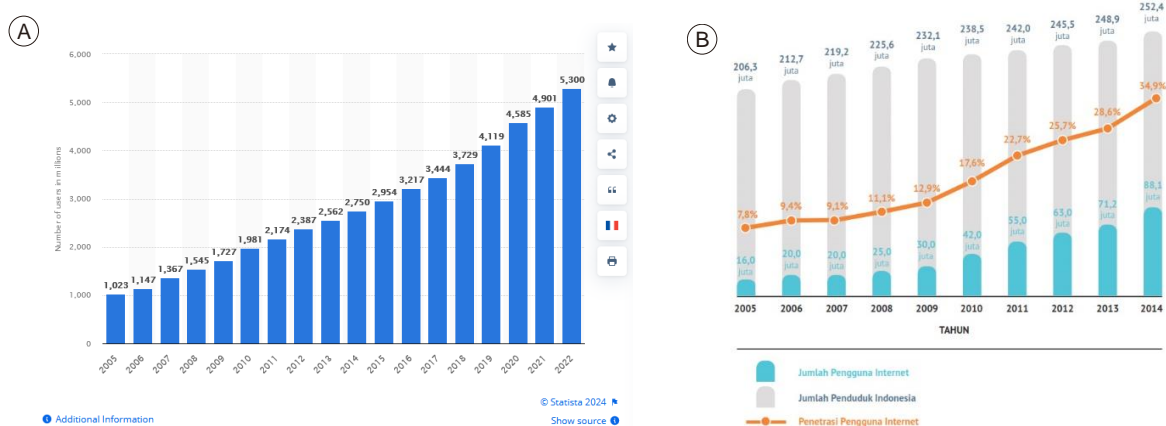


Figure 1. A. World Internet Users (Petrosyan, 2024), B. Internet Users in Indonesia (APJII, 2015).

In 2019, the number of internet users worldwide was 3.97 billion, up from 3.74 billion in the previous year (Statista, 2019). At the end of 2014 internet users in Indonesia reached 88.1 million people or around 34.9 percent of the total population of Indonesia with the total spread covering the regions of Java, Bali, Sumatra, Kalimantan, Nusa Tenggara -Papua-Maluku, and Sulawesi (APJII, 2015). Whereas in 2016 internet users in Indonesia increased to 132.7 million people (APJII, 2016), where students occupy the highest position as internet users. Therefore, the internet has a strong role in the distribution of information as well as knowledge and research. In 2019, internet users in Indonesia increased again to 196.71 million people.

The increasing number of internet users and internet penetration at the global level provides a very wide opportunity for all parties to take advantage of it, including for publication and promotion with various internet-based media. The website is one of the media that is able to provide information and an easy level of accessibility. The number of internet users who reach more 3 billion worldwide with 634 million websites and each year 51 million sites are added to the web, since it was first registered in 1985 there have been around 100 million dot domain names com. In 2012 there were 246 million domain name registrations. (Detik.com, 2013)

High accessibility and several conveniences in building and maintaining a website make it an effective medium for providing information to the public. The existence of this website is expected to help those involved in the world of education in particular and the world community in general who are interested in the field of biology, especially in the field of botany.

The development of photography/digitization technology provides new options in explaining the herbarium recording process for plant identification purposes as well as a database for research and scientific purposes.

We have been successfully developing animal anatomy material to be used by wider audience in the

form of online atlas (Luthfi & Riyanto, 2017). Now, in this research, we combines the fields of biology, photography, and informatics to design an online herbaria website as an initiation for the creation of a virtual herbarium at UIN Sunan Kalijaga. This research seeks to improve accessibility and share data (*free access*) for herbarium collections and is also expected to be a promotional medium for UIN Sunan Kalijaga Yogyakarta to the plant taxonomy community, related to *research* and educational media in the field of botany, plant taxonomy and biodiversity.

MATERIAL AND METHOD

This research is a combination of 4 (four) fields of science; namely biology (botany), photography, graphic design, and informatics. The integration between the science of photography and the science of Biology is in recording herbarium specimen objects, and then processing the image (*Design*) to bring out the *aesthetic value*, and then applying it in the preparation and creation of an online herbarium *database* that can be accessed by many people from various places.

The material and equipment for making herbarium as raw material for website were as follows: plant species, plastic bag, paper, label, thread, a set of herbarium-making tool, oven, and pencil.

The herbarium preparation was performed by a team supervised by Dr. Widodo. All the identification work was done by Dr. Widodo, the taxonomist of UIN Sunan Kalijaga. All specimens were kept in the Integrated Laboratories, UIN Sunan Kalijaga.

The focus of this research was to design, build, and test an online herbarium website. The tools used were:

- Canon EOS 60D camera.
- Laptops with OS *Windows 10*, PHP programming language, *Database Servers MySQL Client*, *Apache local web server*, *Web Browser*, *Sublime Text*, *Adobe Photoshop CS6*, *CorelDRAW X6*.
- Server for *database processing and storage*.

This research was conducted in 5 (five) stages, namely: Literature Study, Data Collection and Processing, System Design, System Testing, and System Implementation Analysis. Here's the description:

- *First*, the study of literature, namely the study of theories related to the identification and classification of plants, photography techniques, theory of website creation and programming languages.
- *Second*, data collection and processing, namely taking photos/pictures of herbarium objects and processing these images with the help of *software* to obtain image data as expected.
- *Third*, creating a website by means of *insourcing* (planning, needs analysis, design, manufacture, & testing) (Mulyanto, 2008)

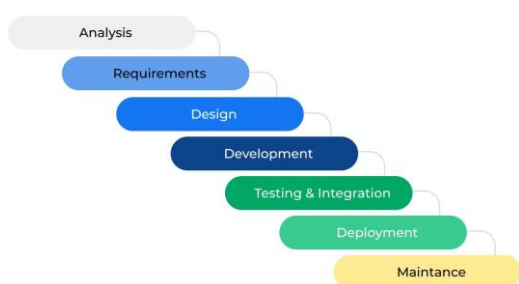


Figure 2. SDLC Scheme (*System Development Life Cycle*). (Photo: intellectsoft.net)

- *Fourth*, system testing. System testing was carried out in two stages; (1) alpha testing, carried out by the research team (focus on functional systems), (2) beta testing, done by external parties (focus on functionality and system interface).
- *Fifth*, system implementation. We carried out the implementation of making a website system so that comprehensive data or facts about the herbarium website were obtained.

RESULTS AND DISCUSSION

In this research, we have successfully developed a website of Virtual Herbarium of Sunan Kalijaga Islamic State University. We used program/soure that already available namely hypertext markup language, javascript, hypertext preprocessor, then manage them into the admin and user system.

HyperText Markup Language document is text document created using any text editor. *Hyper Text Markup Language* is also known as a web *page*. Among the elements forming *the Hyper Text Markup Language*

document are composed by *head*, *table*, *body*, *list*, *paragraph*.

HTML is used to layout, formatting and tells the browser how to display this virtual herbarium. The elements or tags of HTML work together to identify document parts, so the design of the virtual herbarium can be displayed in the browser.

HTML or HyperText Markup Language is the standard markup language for documents designed to be displayed in a web browser (Wikipedia.org). It is the standard markup language for creating Web pages that was invented by Tim Berners-Lee a physicist at the CERN research institute in Switzerland. Tim Berners-Lee also created the first web browser and World Wide Web while working at CERN. The Web was originally conceived and developed to meet the demand for automated information-sharing between scientists in universities and institutes around the world. (CERN, (n.d))

JavaScript is a high-level, prototype-based, object-oriented, multi-paradigm, interpreted or just-in-time compiled, dynamic, single-threaded, garbage-collected programming language with first-class functions and a non-blocking event loop concurrency model (Atalay, 2023). JavaScript is a scripting or programming language that allows to implement complex features on web pages. (developer.mozilla.org). This programming language can work on most of the web browsers. Code usage it can be inserted in the page web using the Script tag (Sunyoto, 2007). In this research, JavaScript are used to create dynamically updating content, control multimedia, and animate images.

PHP (*Hypertext Preprocessor*) is a general-purpose scripting language and interpreter that is freely available and widely used for web development. The language is used primarily for server-side scripting, although it can also be used for command-line scripting and, to a limited degree, desktop applications (Sheldon, 2023). *Hypertext Preprocessor* supports large-scale database web applications. The advantages of PHP are *software open source*, flexible in operating systems and operating systems, and has the ability to execute *databases* quickly. In this research, *Hypertext Prerocessor* are used to generate dynamic content when the page is accessed through a client browser.

Data preparation in the form of herbarium documents was carried out by taking photographs of herbarium collections, and around 130 herbarium photographs were obtained. The pictures below are some photographs of the herbarium collection.

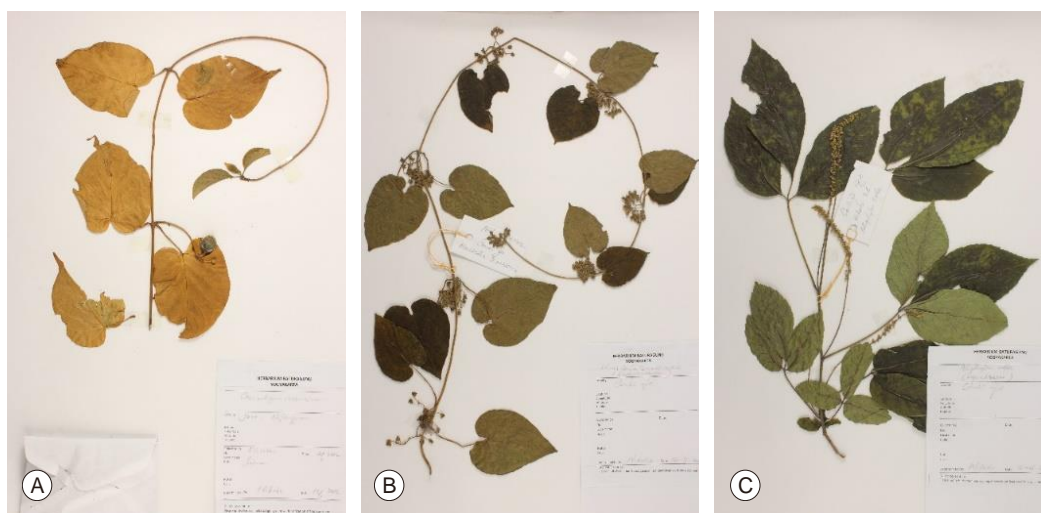


Figure 3. Some photographs of herbarium specimens (A. *Cosmostigma racemosum*, B. *Marsdenia tenacissima*, C. *Allophylus cobbe sapindaceae*).

The admin system is used by the website manager to manage the herbarium museum website, either in the form of adding herbarium collections, editing collections

that have been uploaded, or deleting them. The appearance of the admin page is as follows:

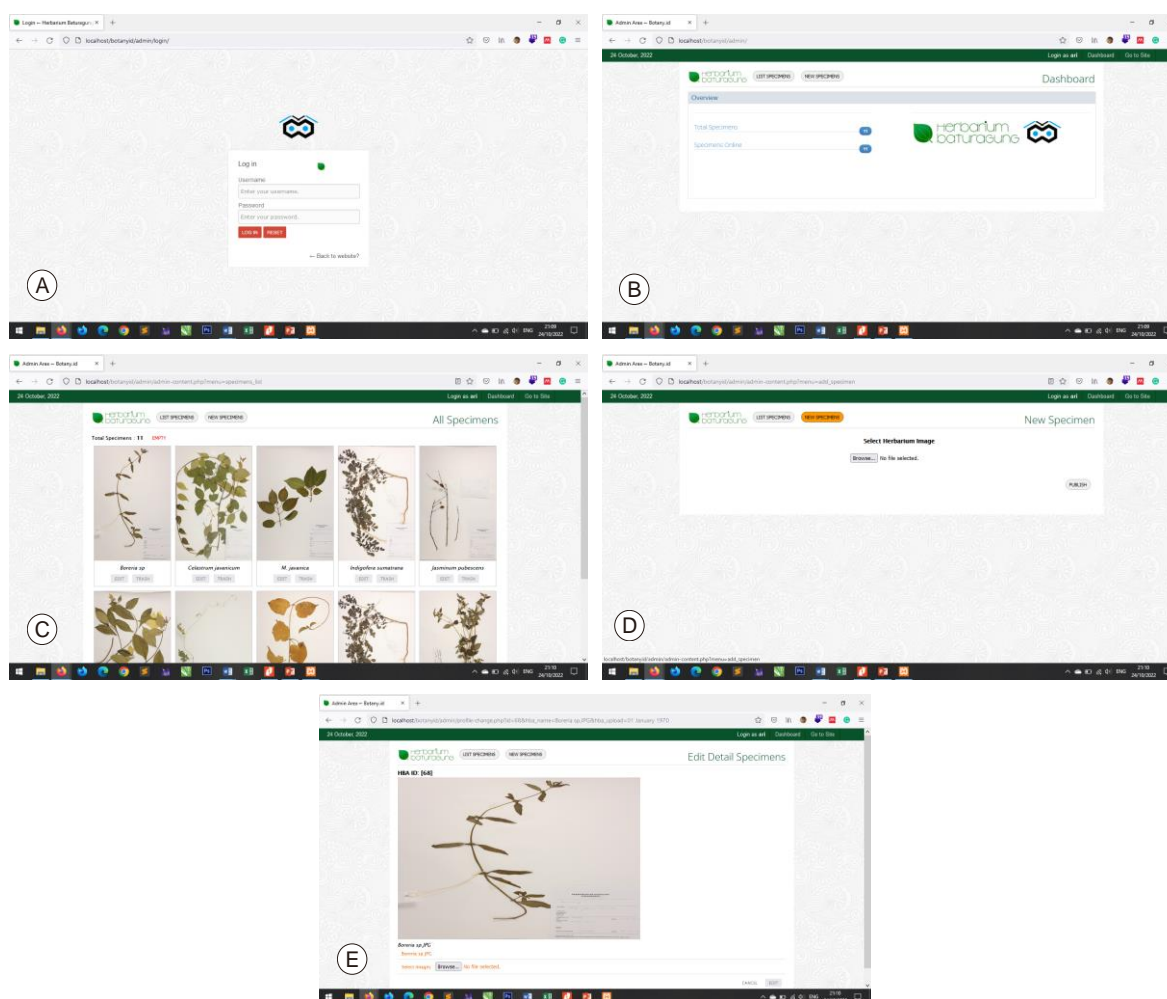


Figure 4. Virtual herbarium of UIN Sunan Kalijaga admin system (A. Login page, B. Main dashboard page, C. Uploaded collection page, D. The page adds to the herbarium collection, E. The page edits the uploaded herbarium collection).

The user system is a system intended for external users who will access the virtual herbarium museum website. On the user page, a list of herbarium collections

is provided, which is displayed as a list of names only or displayed in gallery form.

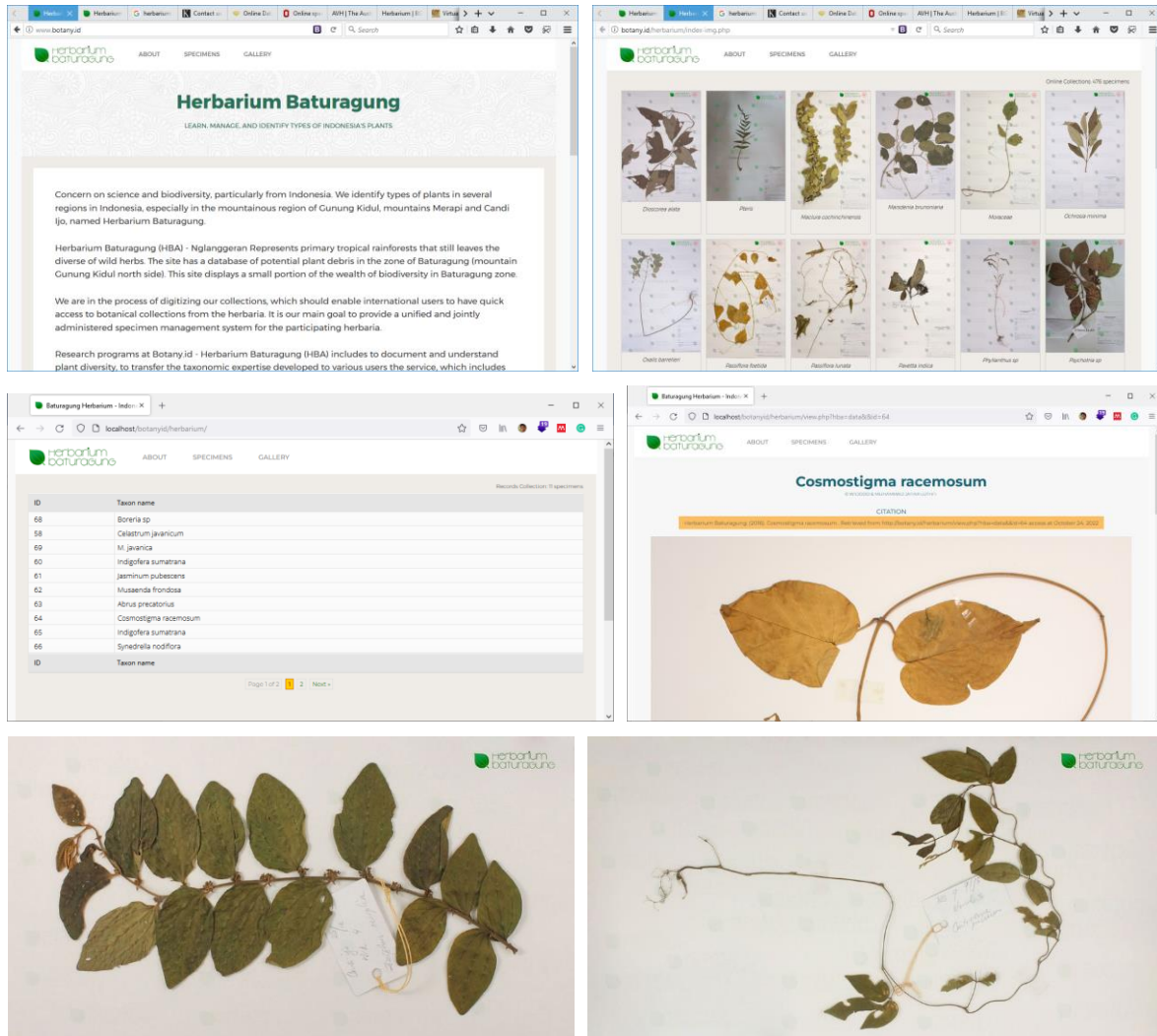


Figure 5. Virtual herbarium of UIN Sunan Kalijaga.

The Virtual Herbarium of Sunan Kalijaga Islamic State University can serve as a raw material for complementary resource in teaching plant anatomy subject, especially in the lab work activity. Lab work activity is a complement in the teaching of plant anatomy subject. Since the character of teaching and learning in the lab work is rather loose, not as rigid as the classroom activity, lecturers, teachers, and students can use this material in a flexible way. It can be embedded into the lab work activity formally or informally, using any pedagogic method available. This virtual herbarium could enrich the plant anatomy knowledge of the students following the lab work activity.

CONCLUSION

From the results of the study, it was concluded that this research had succeeded in building a website-based virtual herbarium museum available online at the site address botany.id. The Virtual Herbarium of Sunan Kalijaga Islamic State University can serve as raw material for complementary resource in teaching plant anatomy subject, especially in the lab work activity.

Acknowledgment: This research is supported and funded by the Institute for Research and Community Service (LP2M) UIN Sunan Kalijaga for the 2022 fiscal year.

Conflicts of Interest: MJL is on the editorial board of the *Biology, Medicine, & Natural Product Chemistry*, and was recused from this article's review and decision. The authors declare that there are no conflicts of interest.

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