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E-Atlas of Epidermal and Stomatal Anatomical Structures in Bougainvillea spp. as an Educational Media for Plant Anatomy

Claudia Jenatris Sendang, Getrudis Wilhelmina Nau*
Universitas Katolik Widya Mandira Kupang
Jl.Jend.Ahmad Yani 50-52 Kupang-85225,NTT-Indonesia
Corresponding author: *getrudisnau@unwira.ac.id

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ABSTRACT

The plant anatomy course studies the internal structures of plant organs, which cannot be observed directly, making it a challenging subject for students. Currently, no instructional media presents direct observation images of the epidermis and stomata of bougainvillea plants, which hinders students' conceptual understanding. This study aims to develop a plant anatomy e-atlas focusing on the epidermis and stomata structures of bougainvillea (Bougainvillea spp.) as an instructional medium, and to evaluate its feasibility. The anatomical structures of the epidermis and stomata were identified from observations of eight bougainvillea varieties found at Widya Mandira Catholic University in Kupang. This research employed a Research and Development (R&D) method using the ADDIE model (Analysis, Design, and Development). The study began with an analysis of the epidermis and stomata structures using the replica method. The results were presented as images and then designed into an atlas format. The feasibility of the e-atlas was evaluated through expert validation. The findings revealed that: (1) The epidermal structure of bougainvillea leaves varies, with some varieties showing elongated and irregular shapes, while others exhibit pentagonal or hexagonal shapes; (2) Five types of stomata were identified: anomocytic, diacytic, paracytic, actinocytic, and anisocytic; (3) The validation results from the content expert and media expert were 84.44% and 83%, respectively, both falling into the 'highly valid' category. In conclusion, although all bougainvillea varieties belong to the same genus, they exhibit diverse epidermal and stomatal structures, and the developed e-atlas is feasible for use as instructional media in plant anatomy courses for Biology Education students.

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INTRODUCTION

Education is a learning process that involves the transfer of knowledge, skills, and habits through teaching, training, or research (Ahmad et al., 2023). In 21st-century learning, students are expected to possess several skills, namely communication, collaboration, problem-solving, and

creativity (Adi et al., 2021). "Life in the 21st century requires individuals to master various skills that are expected and can be developed through education in order for students to succeed. In the field of education, instructional media play a crucial role in helping students understand the material being studied. According to the Association for Education and Communication Technology (AECT), media refers to any form used in the process of delivering information. According to the Education Association, media are objects used in learning activities that can influence the effectiveness of instructional programs (Ramli, 2015). Media are divided into six main categories: text, audio, visuals, video, models (objects), and people. The purpose of media is to facilitate communication and learning. Media are tools, methods, and techniques used to enhance communication and interaction in a more effective educational process (Ahmad et al., 2023).

Based on interviews conducted with students enrolled in the Plant Anatomy course, it was found that some microscopic materials were quite difficult for students to understand, particularly the structure of the epidermis and stomata in plants. This difficulty is compounded by the limited availability of media that can directly display the anatomical parts of plants being studied, making it challenging for students to clearly comprehend the material. Another contributing factor is that the learning resources used in the instructional process do not present clear images, as the visuals shown during lessons are merely black-and-white illustrations. As a result, students' ability to visualize and understand the structure of the epidermal tissue and stomata remains inadequate. Another issue faced is the limited provision of microscopes by the university for student use during observations, which has led to students not fully mastering or understanding how to use a microscope or identify the results of their observations—this becomes a significant obstacle. Furthermore, no previous research has been conducted on bougainvillea plants, particularly concerning the anatomical structure of the epidermis and stomata, to be developed as instructional media for plant anatomy.

Arising from the problems previously described, the limited availability of instructional media for plant anatomy is one of the challenges faced by both lecturers and students during the learning process. One effort to address this issue is the need for an innovative learning medium that can support and facilitate students' learning activities. One type of instructional media suitable for the aforementioned problem is the e-atlas. In this study, an e-atlas was developed with a focus on the sub-topic of the epidermis and stomata structures. This medium is designed with criteria that support students' learning processes, particularly by providing visualizations, such as images

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that allow students to directly observe internal structures—especially the epidermis and stomata—and help them visualize these structures more realistically and in a way that is easier to study. Moreover, this e-atlas learning media can be easily accessed by students via smartphones, computers, and other electronic devices, thus minimizing students' expenses for printing the atlas. Therefore, this electronic atlas represents an appropriate and practical option.

This is supported by previous research which states that an e-atlas can assist in delivering abstract material by making it more concrete (Rosaningdyah et al., 2024). Other studies have shown a significant difference between pre-test and post-test results in the use of e-atlas in biology learning. This indicates that the e-atlas is effective as a learning medium for biology (Ardiana, et al., 2023). In addition, research on the effectiveness of an electronic atlas containing plant biodiversity from Bukit Barisan Selatan National Park (TNBBS) in differentiated biology learning shows that a plant biodiversity atlas is highly suitable for use in biology education. The effectiveness test results showed a score of 0.56, which falls into the moderate category, with the highest effectiveness observed in students with visual learning styles (Wiono et al., 2023). Therefore, this study was conducted to develop an e-atlas of the anatomical structure of the epidermis and stomata in bougainvillea plants as a learning medium for plant anatomy. The novelty of this research lies in the fact that the images presented in the e-atlas are based on the researcher's own identification of the anatomical structures of the epidermis and stomata in bougainvillea. Previously, there has been no e-atlas that contains the anatomical structure of the epidermis and stomata in bougainvillea plants.

RESEARCH METHOD

This type of research falls under research and development (R&D). The method used is descriptive quantitative research, which aims to determine the quality of the e-atlas media based on validation results.

Research Design

This study uses the ADDIE development model, but only up to the third stage: Analyze, Design, and Development. The analysis stage is the process of defining activities such as needs analysis, problem identification, and material analysis. The output of this stage includes an understanding of learner characteristics, gap identification, needs assessment, and task analysis based on the identified needs (Nurdiana, 2019). This stage begins with interviews conducted with biology education students enrolled in the Plant Anatomy course to explore the challenges and

needs they experience during lectures. At this stage, the identification of the anatomical structure of the epidermis and stomata in bougainvillea plants was also carried out as material for content development.

The design stage includes various planning phases in the development of instructional media, starting from designing according to students' needs, such as determining the content, format and size of the media, selecting the type and size of fonts, choosing illustrations for the content, deciding on the color theme of the material to be presented, as well as selecting the language used and writing the media script. The development stage involves the production of the instructional media in the form of an e-atlas. At this stage, the developed media is validated by media experts and subject matter experts to identify any shortcomings, followed by revisions or improvements. Afterward, the media is revalidated to assess its feasibility.

Research Procedure

The tools used to observe the structure of the epidermis and stomata included a microscope, cover glass, label paper, and a camera. The materials used were bougainvillea leaves, clear nail polish, transparent tape, and tissue. The tools and materials used for the development of the e-atlas included a laptop, a camera, and images resulting from observations of the anatomical structure of the epidermis and stomata of bougainvillea leaves. The software used included Microsoft Word and supporting applications such as the Anyflip website.

The steps taken before identifying the structure of the epidermis and stomata on bougainvillea leaves were as follows: the leaves were first wiped with tissue to remove dust and dirt. Then, the clean lower surface of the leaf was coated with clear nail polish and left to dry for approximately 5–10 minutes. After drying, the nail polish layer was covered with transparent tape, pressed evenly, and then slowly peeled off. The resulting imprint was then placed on a microscope slide. Finally, the slide with the imprint was observed under a microscope (Fauziah & Izzah, 2019 dalam Niswatul & Aýun, 2022).

The identified structures of epidermis and stomata were then compiled into a prototype of a plant anatomy e-atlas. This product was subsequently validated by subject matter experts and media experts to assess its feasibility as an instructional medium.

Data Analysis Technique

The data analysis used in this study consists of both qualitative and quantitative analysis. Qualitative data were obtained from feedback and suggestions provided by subject matter experts

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and media experts. Meanwhile, quantitative data were obtained from the assessment questionnaires completed by these experts. The results from the validation sheets provided by the subject matter and media experts were analyzed using descriptive quantitative methods with percentage techniques. To calculate the percentage from the validation sheets, the following formula was used:

$$\textbf{Percentage}\ (\%) = \frac{\textbf{score obtained}}{\textbf{maximum possible score}}\ \textbf{x}\ 100\%$$

With the following criteria for media validation scores:

Table 1. Media Validation Score Criteria

Description	Score	Percentage
Very Invalid	1	0% - 20%
Invalid	2	21% – 40%
Fairly Valid	3	41% - 60%
Valid	4	61% - 80%
Very Valid	5	81% - 100%

Source: (Aziz, 2019)

RESEARCH RESULT

Based on observations of various bougainvillea plant varieties collected from the campus environment of Widya Mandira Catholic University in Kupang, eight varieties of bougainvillea were identified. These eight types include Bougainvillea Afterglow, Bougainvillea Variegata, Bougainvillea Bambino Pedro, Bougainvillea Coconut Ice, Bougainvillea Glabra, Bougainvillea California Gold, Bougainvillea Barbara Karst, and Bougainvillea Cherry Blossom. The following are the epidermis and stomata structures of bougainvillea plants observed under a microscope at 40x and 100x magnification.

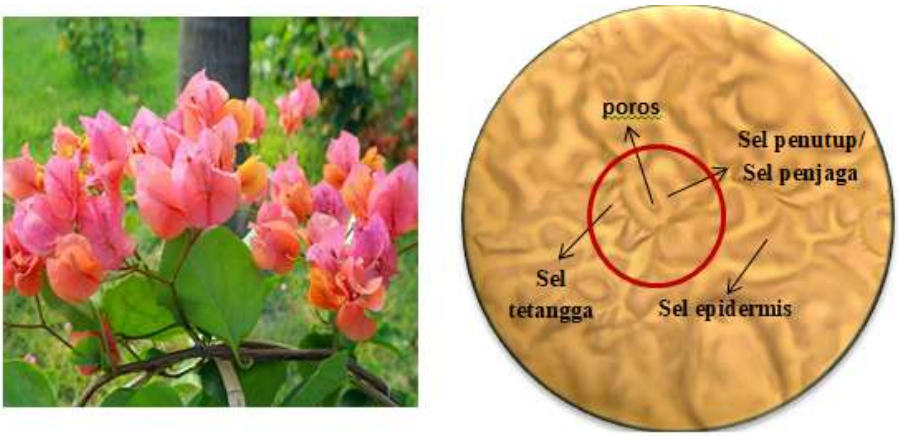

Figure 1. a) Bougainvillea Afterglow b) Epidermis and stomata of Bougainvillea Afterglow

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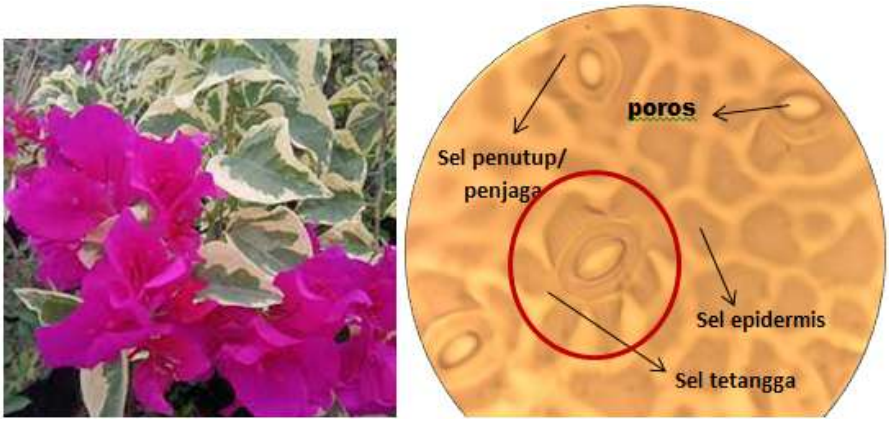

Figure 2. a) Bougainvillea Variegata b) Epidermis and stomata of Bougainvillea Variegata

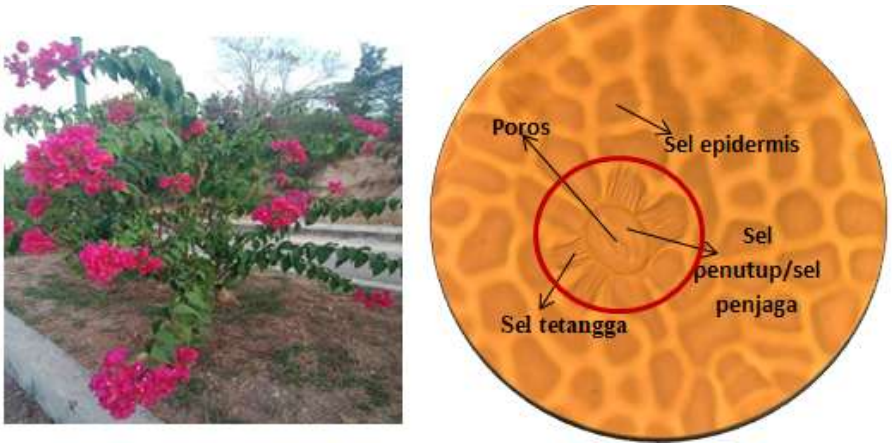

Figure 3. a) Bougainvillea Bambino Pedro b) Epidermis and stomata of Bougainvillea Bambino Pedro

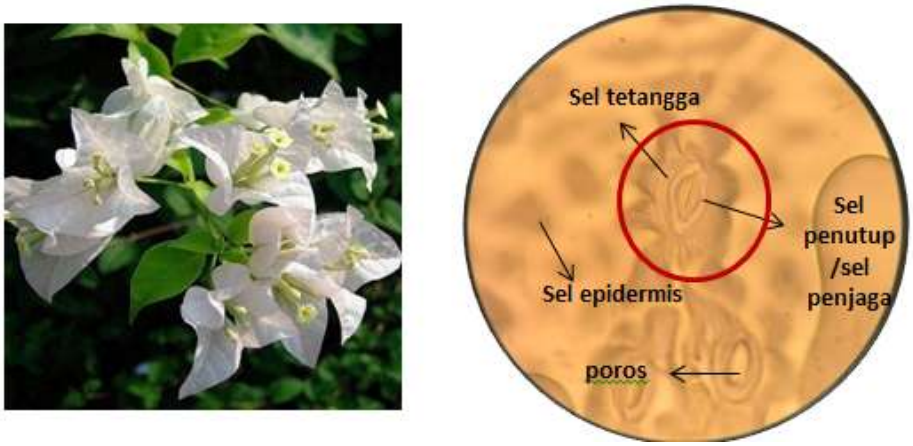

Figure 4. a) Bougainvillea Coconut Ice b) Epidermis and stomata of Bougainvillea Coconut Ice

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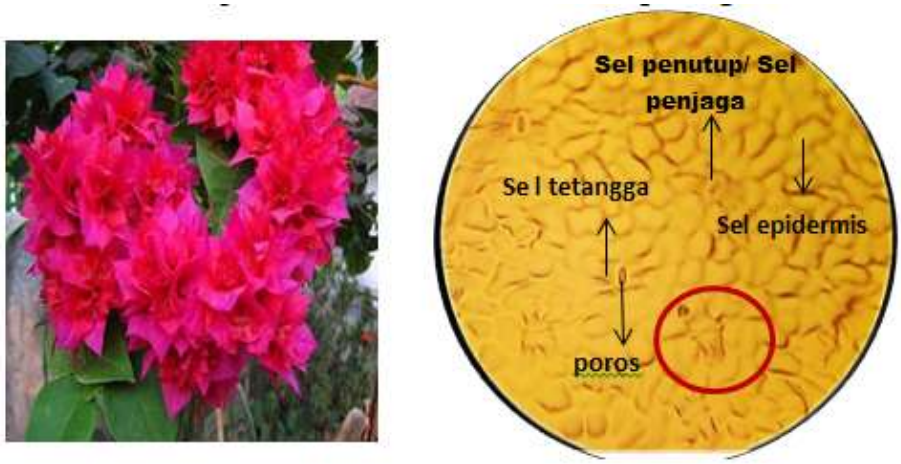

Figure 5. a) Bougainvillea Glabra b) Epidermis and stomata of Bougainvillea Glabra

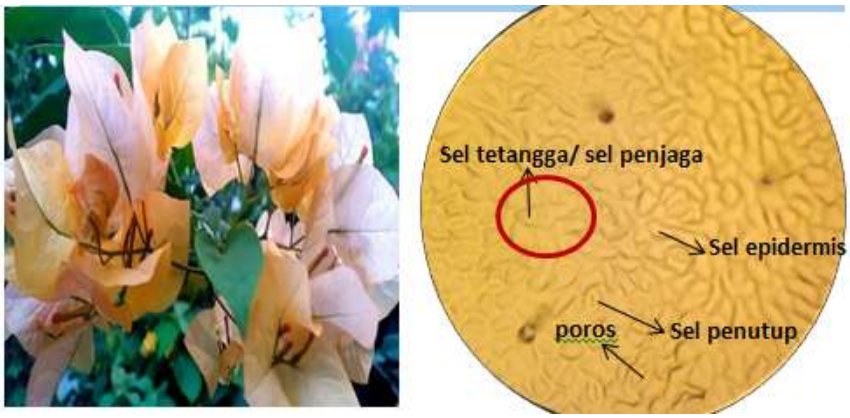

Figure 6. a) Bougainvillea California Gold b) Epidermis and stomata of Bougainvillea California Gold

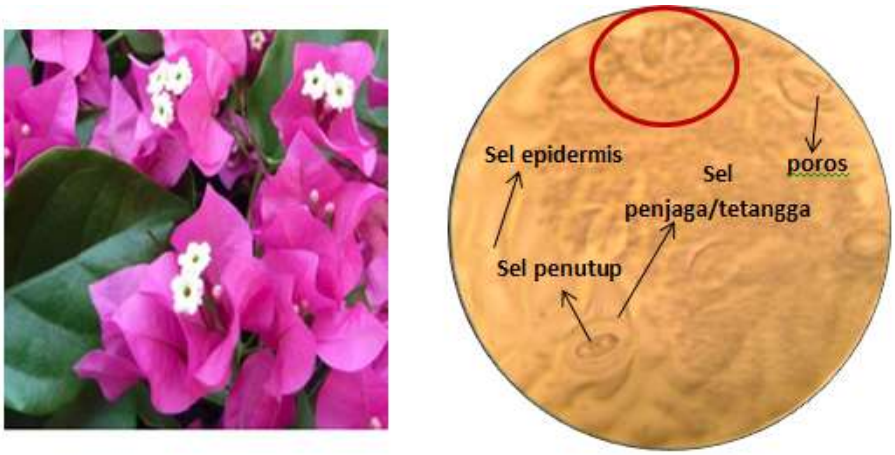

Figure 7. a) Bougainvillea Barbara Karst b) Epidermis and stomata of Bougainvillea Barbara Karst

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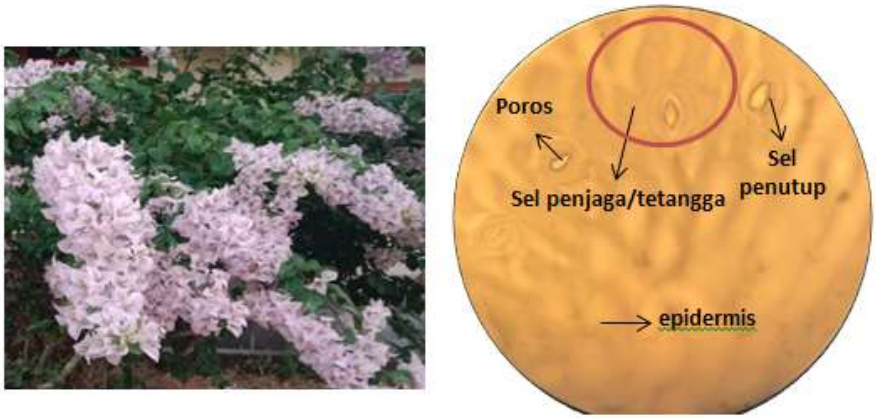

Figure 8. a) Bougainvillea Cherry Blossom b) Epidermis and stomata of Bougainvillea Cherry Blossom

Table 1. Expert Material Validation Results

Total Score Obtained		38
Percentage (%) =	$\frac{obtained\ score}{maximum\ score} x\ 100\%$	$\frac{38}{45} x\ 100\%$ = 84,44 %
Criteria		Highly valid

Table 2. Expert Media Validation Results

Total Score Obtained		83
Percentage (%) =	$\frac{obtained\ score}{maximum\ score} x\ 100\%$	$\frac{83}{100} x\ 100\%$ = 83 %
Criteria		Highly valid

The qualitative data obtained includes input and suggestions from the media expert validator, specifically to add the word "leaf" to the e-atlas title on the cover to avoid ambiguity.

DISCUSSION

The observation of the epidermis and stomata structures in the leaves of various bougainvillea plant types showed that each type possesses different epidermal shapes and stomatal types, despite belonging to the same genus. In terms of epidermal shape, the eight bougainvillea varieties display various forms: the epidermis of Bougainvillea Afterglow, Barbara Karst, Cherry Blossom, and Bambino Pedro is elongated and irregular; Bougainvillea Variegata, Coconut Ice, California Gold, and Glabra exhibit irregular shapes; Bougainvillea Bambino Pedro and Variegata show pentagonal shapes, and Bougainvillea Variegata also displays hexagonal shapes. Meanwhile, five different stomatal types were identified among the eight bougainvillea varieties: anomocytic

(found in Barbara Karst and Cherry Blossom), diacytic (Glabra and California Gold), paracytic (Coconut Ice), actinocytic (Variegata and Bambino Pedro), and anisocytic (Afterglow). The observations were conducted using a microscope with 40x and 100x magnifications. In general, stomatal types can vary from one plant species to another, and even among plants of the same species, different stomatal types may be present, as supported by previous research (Prastika et al., 2023)

Stomata are pores on the epidermis that are flanked by two guard cells. In dicotyledonous plant leaves, the guard cells are generally kidney-shaped, whereas in monocotyledonous plants, they typically have a uniform shape—narrow in the middle and wider at the ends when viewed from the cell surface (Haryanti, 2010). The types of stomata on leaves vary greatly depending on the relationship between the stomata and the surrounding epidermal cells (Prastika et al., 2023). Plants in the class Magnoliopsida generally have kidney-shaped stomata. The stomata are surrounded by guard cells, whose number and position relative to the stomatal pore may vary (Anu et al., 2017). Likewise, epidermal cells can have various shapes.

The differences in stomatal types found among species within the same genus are caused by variations in the plants' adaptive forms to their environment and the habitat in which they grow (Prastika et al., 2023). The variation in stomatal types found in each plant species is a form of adaptation to the environment and habitat in which the plant grows. Modifications in stomatal types can occur even within the same plant species or among different plants of the same genus. In fact, within the same organ—such as leaves of the same plant species—variations in stomatal types may also be observed. The variation of stomatal types within a single genus is influenced by both internal factors (genetic traits) and external factors (habitat or environment) (Prastika dkk., 2023). Based on the results above, it can be concluded that although the eight plant varieties belong to the same genus, *Bougainvillea*, anatomically they exhibit differences in epidermal shapes and stomatal cell types—both in terms of type and form—across each variety or species. These differences are influenced by genetic factors, habitat, and the moisture levels of the environment or habitat in which they grow.

Based on the assessments given by the material expert and media expert validators, the percentage score from the material expert was 84.44%, which falls into the 'very valid' category. Meanwhile, the score obtained from the media expert was 83%, also classified as 'very good'. This

indicates that the learning media is suitable to be used as a teaching tool for plant anatomy to support the learning process and discussions for Biology Education students.

In addition, qualitative data in the form of suggestions and input from the media expert validator included the recommendation to add the word 'leaf' to the title of the e-atlas to avoid ambiguity, as epidermal structures are not only found on leaves but also on roots, stems, seeds, fruits, and flowers. Ambiguity is a linguistic error—whether in words, phrases, or sentences—that leads to unclear communication. Such ambiguity can result in misunderstandings when interpreting learning resources (Suwarna, 2022). Therefore, the writing of teaching materials and learning media should use effective sentences. Effective sentences can enhance reader comprehension, strengthen the message being conveyed, and minimize the potential for misunderstandings (Sofwan, et al., 2024). Based on the validator's suggestion to avoid ambiguity and considering the importance of using effective sentences, the title on the cover—originally *E-Atlas of the Anatomical Structure of the Epidermis and Stomata of Bougainvillea Plant Varieties (Bougainvillea spp.)*—was revised to *E-Atlas of the Anatomical Structure of Leaf Epidermis and Stomata of Bougainvillea Plant Varieties (Bougainvillea spp.)*.

CONCLUSION

The epidermis and stomata of bougainvillea plants differ despite belonging to the same genus. Bougainvillea plants have various epidermal shapes, including elongated, irregular, pentagonal, and hexagonal forms. Five types of stomata were found among the eight bougainvillea plant varieties: anomocytic, diacytic, paracytic, actinocytic, and anisocytic. Differences in epidermal structure and stomatal types among species within the same genus are influenced by internal factors (genetic traits) and external factors (habitat or environment), including species-specific adaptations to their surroundings, the habitat in which the plants grow, and the moisture levels of the environment or habitat.

Based on the results of the research presented, the developed e-atlas of the anatomical structure of the epidermis and stomata of various bougainvillea plant species (Bougainvillea spp.) is deemed suitable for use as a learning medium in plant anatomy. The e-atlas has undergone a validity test, with the assessments by subject matter experts and media experts yielding feasibility percentages of 84.44% and 83%, respectively, which fall into the 'very valid' category. The results of this study can serve as a foundation for future researchers to conduct practicality and effectiveness tests of the product for implementation in learning activities.

REFERENCE

Adi, E. P., Pramudita, I. F. E., & Praherdhiono, H. (2021). Studi Keterampilan Abad 21 Mahasiswa Dalam Memilih Peminatan. *JKTP: Jurnal Kajian Teknologi Pendidikan*, *4*(3), 251–259. https://doi.org/10.17977/um038v4i32021p251

Afrina, N., Sinaga, S. A., Harahap, A. A., Hartady, A. B., & ... (2023). Identifikasi Spesies Bougenville di Kecamatan Medan Johor. *Jurnal Pendidikan …*, *7*, 30668–30676. https://jptam.org/index.php/jptam/article/view/11963%0Ahttps://jptam.org/index.php/jptam/article/download/11963/9217

Ahmad, S. N. M., Karim, H., & Azis, A. A. (2023). Uji Kepraktisan Media Pembelajaran E-Atlas Preparat Fotografi Anatomi Tumbuhan Monokotil Familia Poaceae. *Jurnal Biogenerasi*, *8*(2), 510–515. https://doi.org/10.30605/biogenerasi.v8i2.2898

Annisa, L. arbaatin. (2021). Pengembangan Media Pembelajaran Berbasis Video Animasi Pada Tema 7 Subtema 3 Untuk Siswa Kelas Iv Sdn 104 Pekanbaru Skripsi. *Program Studi Pendidikan Guru Sekolah Dasar Fakultas Keguruan Dan Ilmu Pendidikan Universitas Islam Riau*, 89. http://www.nber.org/papers/w16019

Anu, O., Rampe, H. L., & Pelealu, J. J. (2017). Struktur Sel Epidermis dan Stomata Daun Beberapa Tumbuhan Suku Euphorbiaceae. *Jurnal MIPA*, *6*(1), 69–73.

Apriyanti, D. (2023). *Variasi morfologi Bunga Kertas (Bougainvillea spectabilis Willd .) di Desa Paya Tampah , Kabupaten Aceh Tamiang*. *4*, 1–4.

Ardiana, R. (2022). *Pengembangan E-Atlas Vertebrata Sebagai Media Pembelajaran Biologi Pada Materi Animalia Untuk Siswa Kelas X Ipa Di SMA Panca Marga 1 Lamongan* (Issue November).

Ariyansyah, A. (2018). Penerapan Beberapa Keterampilan Abad 21 Melalui Metode Kuliah Lapangan (Field Trip) untuk Meningkatkan Kualitas Pembelajaran Taksonomi Tumbuhan Tingkat Rendah. *Oryza (Jurnal Pendidikan Biologi)*, *7*(1), 1–9. https://doi.org/10.33627/oz.v7i1.11

Aryanto, J. (2014). Taksonomi Polypodiaceae Ditinjau Dari Type Stomata Taksonomy. *Seminar Nasional XI Pendidikan Biologi FKIP UNS*, 189–194.

Aulia, O. M., Amintarti, S., & Rezeki, A. (2023). Tipe-Tipe Stomata Tumbuhan Myrtaceae Di Lingkungan Kampus Fkip Ulm Sebagai Booklet Bahan Ajar Pendamping Mata Kuliah Anatomi Tumbuhan. *BIOEDUKASI (Jurnal Pendidikan Biologi)*, *14*(2), 230. https://doi.org/10.24127/bioedukasi.v14i2.7791

Aziz, R. (2019). Pengembangan Media Pembelajaran Maket 3D Geo grafi Pada Materi Lipatan dan Patahan Patahan, Pengembangan Media Pembelajaran Maket 3D Pada Materi Lipatan dan. *Swara Bhumi E-Journal Pendidikan Geografi FIS Unesa*, *Vol 5*(1), 2.

Cristanti, W. (2021). *Struktur Sel Epidermis Dan Stomata Pada Daun Beberapa Tumbuhan Suku Moraceae Dan Sumbangannya Pada Pembelajaran Biologi SMA*. Universitas Sriwijaya.

Dayatmi, T., Khair, H., & Binjai, K. (2021). Identifikasi Bunga Kertas (Bougenville) Berdasarkan Warna dengan Metode K-Nearest Neighbor (KNN). *Algoritma: Jurnal Ilmu Komputer Dan Informatika*, *6341*(November), 2.

Fauziah, A., & Izzah, A. S. Z. (2019). Analisis Tipe Stomata Pada Daun Tumbuhan Menggunakan

Metode Stomatal Printing. *Proding Seminar Nasional Hayati*, *7*(September), 34–39.

Furqan, M., & Harahap, L. S. (2020). Klasifikasi Daun Bugenvil Menggunakan Gray Level Co-Occurrence Matrix dr. *Klasifikasi Tanaman Bougenville*, *6*(1), 22–29.

Haryanti, S. (2010). Jumlah dan distribusi stomata pada daun beberapa spesies tanaman dikotil dan monokotil. *Buletin Anatomi Dan Fisiologi*, *18*(2), 21–28.

Hidayat, W. (2023). *Struktur Sel Epidermis Dan Stomata Daun Suku Orchidaceae Sebagai Penunjang Matakuliah Praktikum Anatomi Tumbuhan*.

Hindriana, Anna, F. dan H. (2023). *Anatomi Tumbuhan*.

Ishaq, M., Mufidah, & Alfian, R. (2022). Studi Komparasi Variasi Struktur Sel Epidermis Dan Stomata Pada Beberapa Tanaman Familia Euphorbiaceae. *Prosiding Seminar Nasional MIPA UNIBA 2022*, *2*(Vol. 2 No. 1 (2022): SEMNAS KNMIPA II : STEAM (Society Technology, Engineering, Art And Mathematics)), 1–6.

Kumekawa, Y., Miyata, H., Ohga, K., Hayakawa, H., Yokoyama, J., Ito, K., Tebayashi, S., Arakawa, R., & Fukuda, T. (2013). Comparative Analyses of Stomatal Size and Density among Ecotypes of <i>Aster hispidus</i> (Asteraceae). *American Journal of Plant Sciences*, *04*(03), 524–527. https://doi.org/10.4236/ajps.2013.43067

Maryati, I., Saputra, H. J., & Arisyanto, P. (2024). *Pengembangan Media Pop-Up Book Pada Tema 8 Sub Tema 1 Pembelajaran 2 Kelas V SD Negeri 2 Penawangan Kabupaten Grobogan Tahun Ajaran 2022 / 2023 Fakultas Ilmu Pendidikan , Universitas PGRI Semarang Abstak*. *4*(1), 167–176. https://doi.org/10.26877/ijes.v4i1.18468

Nasrianti syam, Arlya Kurniawati, Seri Devi, Z. I. N. Z. M. L. (2023). Identification Of Morphological Character And Benefits Of Paper Flower (Bougainvillea) In Seneren Village, Pantan Cuaca District, Gayo Lues District, Aceh. *Journal of Education Science*, *9*(1), 78–83.

Niswatul, S., & Aýun, Q. (2022). Identifikasi Dan Karakterisasi Tipe Stomata Pada Hibiscus tosa-sinensis, Tamarindus indica, dan Mangifera indica Dengan Teknik Replika. *Jurnal Pendidikan Dan Sains Biologi*, *5*(1), 9–14. https://doi.org/10.33323/indigenous.v5i1.295

Nurdiana, D. E. (2019). Pengembangan Media Pembelajaran Cd Interaktif Terintegrasi Nilai Islam Disertai Dengan Mind Mapping Pada Materi Jaringan Epitel Kelas Xi Sma Negeri 16 Semarang. In *Skripsi*.

Prastika, D., Sarjani, T. M., Mahyuni, S. R., Hariani, I., Ramadhan, D. A., Rezeki, S., Tiara, R., Hendrik, E., Aulia, R., & Amalia, T. (2023). Identifikasi Tipe Stomata Anggota Suku Myrtaceae di Kota Langsa. *Jurnal Sains Dan Edukasi Sains*, *6*(1), 20–27. https://doi.org/10.24246/juses.v6i1p20-27

Putriani, A., Prayogo, H., & Wulandari, R. S. (2019). Karakteristik Stomata Pada Pohon Di Ruang Terbuka Hijau Universitas Tanjungpura Kota Pontianak. *Jurnal Hutan Lestari*, *7*(2), 746–751. https://doi.org/10.26418/jhl.v7i2.33629

Ramli. M. (2015). Media Pembelajaran Dalam Perspektif Al-Qur'an Dan Al-Hadits. *Andragogi: Jurnal Diklat Teknis Pendidikan Dan Keagamaan*, *13*(23), 130–154. https://doi.org/10.36052/andragogi.v6i2.59

Rohmawati, M. (2015). Karakterisasi Morfologi Dan Anatomi Pegagan (Centella Asiatica (L.) Urban.) Di Kabupaten Batang Sebagai Sumber Belajar Pada Mata Kuliah Praktikum

Morfologi Dan Anatomi Tumbuhan [Universitas Islam Negeri Walisongo Semarang]. In *11th International Conference on Control, Automation, Robotics and Vision, ICARCV 2010*. https://doi.org/10.1109/ICARCV.2010.5707366

Rosaningdyah, A. R., & Rudyatmi, E. (2024). Pengembangan E-Atlas Strukutr Tumbuhan Berbiji sebagai Media Pembelajaran pada Materi Jaringan, Organ, dan Sistem Organ pada Tumbuhan di SMA. *Prosiding Semnas Biologi XII FMIPA UNS*, 191-197.

Sabandar, A., Hiariej, A., & Sahertian, D. E. (2021). Struktur Sel Epidermis Dan Stomata Aegiceras corniculatum D dan Rhizophora apiculata pada Muara Sungai Desa Poka dan Desa Leahari. *Biosel: Biology Science and Education*, *10*(1), 81. https://doi.org/10.33477/bs.v10i1.1896

Sari, R. I. (2019). Analisis Tingkat Kemandirian Belajar Siswa Pada Mata Pelajaran Fisika Kelas XII MAN 1 Batang Hari. *Jurnal Pendidikan Fisika Dan Teknologi*, *5*(2), 296–304. https://doi.org/10.29303/jpft.v5i2.1436

Sari, W., Jufrida, & Pathoni, H. (2017). Pengembangan Modul Elektronik Berbasis 3D Pageflip Professional pada Materi Konsep Dasar Fisika Inti dan Struktur Inti Mata Kuliah Fisika Atom dan Inti Mahasiswa S1 Program Studi Pendidikan Fisika FKIP Universitas Jambi 2)3). *Jurnal EduFisik*, *02*(01). http://nugraha167.blogspot.com

Sarjani, T. M., Mawardi, M., Pandia, E. S., & Wulandari, D. (2017). Identifikasi Morfologi Dan Anatomi Tipe Stomata Famili Piperaceae Di Kota Langsa. *Jurnal IPA & Pembelajaran IPA*, *1*(2), 182–191. https://doi.org/10.24815/jipi.v1i2.9693

Setiawati, D. A. (2018). *Pengembangan Media Pembelajaran E-Atlas Berbasis Mobile Learning Pada Materi Struktur Sel Di SMAN 1 Kadangserang*. 12–13.

Setyaedhi, H. S. (2021). Peranan Media Pembelajaran Dalam Kurikulum 2013. *Educational Technology Journal*, *1*(1), 19–30. https://doi.org/10.26740/etj.v1n1.p19-30

Sofwan, M. Z., Farida, Arroyo, M., Sa'diyah, H., Junianti, A. D., & Andrean, M. R. (2024). Optimalisasi Penggunaan Kalimat Efektif untuk Meningkatkan Komunikasi yang Jelas. JIIC: *Jurnal Intelek Insan Cendikia, 1(10)*, 6799-6808.

Suhardi, M., & Zinnurain. (2021). Peningkatan Kesiapan Diri Berdasarkan Ability, Skill, Demeanor Dalam Menghadapi Revolusi Industri 4.0 Bagi Mahasiswa. *Modul Biokimia Materi Metabolisme Lemak, Daur Asam Sitrat, Fosforilasi Oksidatif Dan Jalur Pentosa Fosfat*, *4*(2), 525–538.

Suwarna, D. (2022). Ambiguitas sebagai Persoalan Bahasa dan Tanda Baca. *Media Bahasa, Sastra, dan Budaya Wahana, 28(1)*, 618-623.

Ulumuddin, A. (2021). Pengembangan Media Pembelajaran Melalui Aplikasi Anyflip Di Sekolah Dasar Dalam Mengembangkan Literasi Bahasa. *Seminar Nasional Literasi*, 494–502. http://conference.upgris.ac.id/index.php/snl/article/view/2775%0Ahttp://conference.upgris.ac.id/index.php/snl/article/download/2775/1616

Umaternate, H., Munawar, S., & Soamole, R. (2022). Karakteristik Morfologi Bunga Kertas (Bougenville). *JBES: Journal of Biology Education and Science*, *2*(2), 76–85.

Winarta, W. N. S. (2022). *Respon Pertumbuhan Dua Jenis Tanaman Bugenvil (Bougainvillea spp.) Terhadap Pemberian Berbagai Pupuk Organik Cair*. http://repository.uin-suska.ac.id/62319/

Wiono, W. J., Priadi, M. A., & Meriza, N. (2023). *Efektivitas Atlas Elektronik Bermuatan Keanekaragaman Tumbuhan Tnbbs Dalam Pembelajaran Biologi Berdiferensiasi*.

Zubaidah, S. (2020). *Keterampilan Abad Ke-21: Keterampilan yang Diajarkan Melalui Pembelajaran. Online*. *2*, 1–17.