

Potential of Bintangur (*Calophyllum* spp.) Diversity in West Kalimantan as a Biology Learning Resource in Senior High School

Mas Akhbar Faturrahman^{1*}, Kurnia Ningsih¹, Klaudia Mareta Sandra¹, Widya Astuti¹, Isyatirradhiyah¹, Nambisas Arum Kusuma Ayu¹, Nur Salsabila¹, Artha Bayu Afifah², Aurendyo Yuscel Perdana²

¹Biology Education Study Program, Tanjungpura University, Pontianak, Indonesia

²Biology Study Program, Tanjungpura University, Pontianak, Indonesia

*E-mail: masakhbar123@gmail.com

Received: September 13, 2024. Accepted: November 22, 2024. Published: November 30, 2024

Abstract: Indonesia is one of the countries with a very high level of biodiversity. West Kalimantan is one of the provinces with the highest level of biodiversity in Indonesia. One form of biodiversity found in West Kalimantan's forests is bintangur (*Calophyllum* spp.). The very high diversity of bintangur species is fascinating to be utilized as a source of learning biology, especially in the material of biodiversity and their interactions and roles. This study aimed to analyze the potential of bintangur diversity in West Kalimantan as a biology learning resource on the material of biodiversity and their interactions and roles in senior high school. This research uses the qualitative method. This research consists of two stages. The first stage is a literature review to find information related to bintangur species in West Kalimantan. In contrast, the second stage is an analysis of learning resource requirements based on the results of the literature review that has been carried out. The results of the literature review stage show that there are 27 species of bintangur in West Kalimantan, as well as their classification, main characteristics, habitats, and values to the environment and other organisms. The literature review stage results are then continued to the learning resources analysis. Six requirements must be met for learning resources: clarity of the potential availability of objects and problems raised, suitability for learning objectives, clarity of targets and their designation, clarity of information disclosed, clarity of exploration guidelines, and clarity of the results to be achieved. The analysis of learning resource requirements that have been carried out shows that the diversity of bintangur species in West Kalimantan meets the requirements of learning resources so that it can be utilized as a biology learning resource on the material of biodiversity and their interactions and roles in senior high school.

Keywords: Bintangur; Biodiversity; Biology Learning Resource; *Calophyllum*; West Kalimantan.

Introduction

Indonesia is one of the countries with a very high level of biodiversity [1-3]. Biodiversity is a term used to describe the variation of life forms at various levels of organization in a geographical area [4-5]. West Kalimantan is one of the provinces with the highest level of biodiversity in Indonesia [6]. Extensive forests in West Kalimantan encourage the high biodiversity level it contains [7]. One form of biodiversity found in West Kalimantan's forests is bintangur (*Calophyllum* spp.).

Bintangur is a genus of Clusiaceae family plant [8-9]. Bintangur are distributed in tropical forests in South China, Southeast Asia, East Asia, Madagascar, the Pacific Islands, the Americas, Australia, and Brazil [10]. The majority of members of this genus are trees or shrubs [11] and have varied economic and ecological values [8, 12]. Bintangur habitats range from wet tropical rainforests at low elevations to drier areas at higher elevations [13]. Bintangur is known for its very high level of species diversity. To date, it is known that there are more than 180 species of bintangur [8, 10].

The diversity of bintangur species in West Kalimantan can be utilized as a learning resource in biology subjects in high schools. Learning resources are anything

students can use to support and facilitate learning activities [14-16]. Biology subjects study various concepts related to organisms [17-18], one of which is the diversity of organisms. Information on the diversity of bintangur species in West Kalimantan is interesting to be implemented in learning material on biodiversity and their interactions and roles.

Integrating bintangur species diversity in West Kalimantan is exciting because students in West Kalimantan can learn more about biodiversity in their region. Biodiversity-based learning aims to make students recognize the biodiversity in their area, primarily where the specific learning is carried out [19]. It allows students to engage with real-world examples of species diversity and ecological interactions, fostering a hands-on approach to learning. This research aims to analyze the potential of bintangur diversity in West Kalimantan as a biology learning resource on the material of biodiversity and their interactions and roles in senior high school. The urgency of this research is the need for summarized information related to local biodiversity as a material to enrich learning resources in biology subjects, especially on the material of biodiversity and their interactions and roles. Increased knowledge of local biodiversity can increase students' awareness of the importance of biodiversity and encourage them to take

How to Cite:

Faturrahman, M. A., Ningsih, K., Sandra, K. M., Astuti, W., Isyatirradhiyah, I., Ayu, N. A. K., ... Perdana, A. Y. (2024). Potential of Bintangur (*Calophyllum* spp.) Diversity in West Kalimantan as a Biology Learning Resource in Senior High School. *Jurnal Pijar Mipa*, 19(6), 1018-1024. <https://doi.org/10.29303/jpm.v19i6.7642>

participatory action in preserving the environment and its organisms.

Research Methods

This research uses qualitative methods. Qualitative research explores concepts, characteristics, and descriptions of a phenomenon to be presented narratively [20]. This research is divided into two stages. The first stage is a literature review to find information on the diversity of bintangur species in West Kalimantan. The second stage is analysing learning resource requirements based on the literature review.

Literature Review

A literature review analyses secondary data in documents related to the research topic to produce comprehensive data [21-23]. The literature review procedure in this research refers to [24], which starts from determining the topic, searching for literature, analysing the results, and writing the manuscript. Secondary data were obtained with the help of the Publish or Perish application using several keywords, such as “*Calophyllum*,” “Bintangur,” and “West Kalimantan.” The secondary data used in this study were obtained from scientific journals (reputable and non-reputable), conference proceedings (national and international), books, and theses (undergraduate, master, and doctoral), with a period limited from 2014 to 2024. The restriction was made to see the development of relevant data related to the research topic per decade [25]. The distribution data of each bintangur species obtained from the secondary data sources is confirmed using the *Plants of the World Online* site.

Learning Resource Analysis

The analysis of learning resource requirements is a stage to determine the suitability between the potential results of writing and learning resource requirements [26]. The analysis of learning resource requirements in this research refers to Suhardi (in [26-29]). Six requirements must be met: clarity of the potential availability of objects and problems raised, suitability for learning objectives, clarity of targets and their designation, clarity of information disclosed, clarity of exploration guidelines, and clarity of the results to be achieved.

Results and Discussion

***Calophyllum* spp. Diversity in West Kalimantan**

Bintangur, also known as tikfer [30], is a genus of plants commonly known among Indonesians. Bintangur is distributed in tropical forests in South China, Southeast Asia, East Asia, Madagascar, the Pacific Islands, America, Australia, and Brazil [10]. Bintangur classification can be seen in Table 1 [9].

Bintangur is known for its high level of species diversity. To date, there are more than 180 species of bintangur [8, 10]. Bintangur species can also be found in West Kalimantan. Based on the literature review conducted, 27 species of bintangur were found in West Kalimantan. The

results of data collection of bintangur species in West Kalimantan are presented in Table 2.

Table 1. Bintangur classification

| | |
|---------------|---------------|
| Kingdom | Plantae |
| Subkingdom | Tracheobionta |
| Superdivision | Spermatophyta |
| Division | Magnoliophyta |
| Class | Magnoliopsida |
| Subclass | Dilleniidae |
| Order | Theales |
| Family | Clusiaceae |

Table 2. Bintangur species diversity in West Kalimantan

| No. | Species | References |
|-----|-----------------------------------|------------|
| 1 | <i>Calophyllum ardens</i> | [31] |
| 2 | <i>Calophyllum calaba</i> | [32] |
| 3 | <i>Calophyllum calcicola</i> | [33] |
| 4 | <i>Calophyllum canum</i> | [34] |
| 5 | <i>Calophyllum garcinoides</i> | [31] |
| 6 | <i>Calophyllum griseum</i> | [31] |
| 7 | <i>Calophyllum havilandii</i> | [31] |
| 8 | <i>Calophyllum hosei</i> | [35] |
| 9 | <i>Calophyllum incrassatum</i> | [11] |
| 10 | <i>Calophyllum inophyllum</i> | [36] |
| 11 | <i>Calophyllum lanigerum</i> | [37] |
| 12 | <i>Calophyllum macrocarpum</i> | [32] |
| 13 | <i>Calophyllum mukunense</i> | [31] |
| 14 | <i>Calophyllum obliquinervium</i> | [38] |
| 15 | <i>Calophyllum praetermissum</i> | [31] |
| 16 | <i>Calophyllum pseudomole</i> | [39] |
| 17 | <i>Calophyllum pulcherrimum</i> | [40] |
| 18 | <i>Calophyllum pyriforme</i> | [31] |
| 19 | <i>Calophyllum recurvatum</i> | [31] |
| 20 | <i>Calophyllum ridleyi</i> | [41] |
| 21 | <i>Calophyllum rigidum</i> | [35] |
| 22 | <i>Calophyllum sclerophyllum</i> | [36] |
| 23 | <i>Calophyllum soulattri</i> | [42] |
| 24 | <i>Calophyllum tetrapterum</i> | [43] |
| 25 | <i>Calophyllum teysmannii</i> | [44] |
| 26 | <i>Calophyllum wallichianum</i> | [45] |
| 27 | <i>Calophyllum woodii</i> | [31] |



Figure 1. *Calophyllum inophyllum* tree [46]

Bintangur habitats range from wet tropical rainforests at low elevations to drier areas at higher elevations [13]. The majority of members of this genus are trees or shrubs [11]. There are few characteristics of this genus: the outer bark is reddish and marked with diamond-shaped cracks; the leaves are uniquely opposite in arrangement, featuring narrow parallel veins alternating with resin canals, often growing on petioles; the flowers are arranged in racemes or thyrses, emerging from the leaf axils or branch tips, either terminally or axillary; the sepals and petals form in hermaphroditic flowers; the fruit is a drupe, with a thin layer of flesh surrounding a large seed, and it exudes white or yellow latex [47].

Bintangur has economic value. Bintangur stems are commonly used as construction materials [48]. Specifically, *Calophyllum soulattri* stems can be utilized as flooring materials, decorative boards, household furniture, plywood, pulp, and veneer [49]. Bintangur also contains various secondary metabolite compounds that can be utilized in the pharmaceutical industry. Antioxidant activity was shown by extracts of *Calophyllum incrassatum* [50], *Calophyllum pulcherrimum*, *Calophyllum soulattri*, *Calophyllum teysmannii* [51], *Calophyllum sclerophyllum* [52], and *Calophyllum lanigerum* [53]. *Calophyllum inophyllum* contains antiviral, anticancer, antimicrobial, anti-inflammatory, antioxidant, antiplatelet, antiulcer, wound

healing activities, and protection against ultraviolet light [54]. *Calophyllum wallichianum* extract has potential as an antibacterial [45]. *Calophyllum pulcherrimum* resin is traditionally utilized by the community around Sambas Botanical Garden, Sambas Regency, as a cancer drug [40]. *Calophyllum inophyllum* can also be used as biodiesel [55]. In addition, bintangur has ecological value. The leaves and fruits of *Calophyllum inophyllum* are consumed by several species of primates [56]. *Calophyllum inophyllum* is also known to grow in various soil types and is a solution for revegetation [57].

Learning Resource Analysis

The literature review results for the diversity of bintangur species in West Kalimantan have potential as a learning resource in biology subjects, especially in the material on biodiversity and their interactions and roles. However, this potential must first be analyzed using the analysis of learning resource requirements to review the availability of potential and its suitability for learning outcomes in the current curriculum [58]. The analysis of learning resource requirements refers to Suhardi (in [26-29]). The results of the analysis of learning resource requirements that have been carried out can be seen in Table 3.

Table 3. Learning resource requirements analysis result

| No. | Learning Resource Requirements | Results |
|-----|--|--|
| 1 | Clarity of the potential availability of objects and problems raised | The potential studied is the high level of diversity of bintangur species in West Kalimantan. This potential can be a solution to overcome the limited knowledge of students in West Kalimantan about the diversity of bintangur species, so its implementation is needed as a learning resource on the material of biodiversity and their interactions and roles. |
| 2 | Suitability for learning objectives | The results of the study of bintangur species diversity in West Kalimantan can be implemented into the material on biodiversity and their interactions and roles. The learning objectives, which are based on the literature review results, are “Identify the levels of biodiversity”, “Describe Indonesia’s biodiversity”, “Describe the kingdom of Plantae”, and “Analyze the interaction of organisms in their ecosystem”. |
| 3 | Clarity of targets and their designation | The search results related to the diversity of bintangur species in West Kalimantan targets the material on biodiversity and its interactions and roles, which is part of the biology subject in class X of senior high school. |
| 4 | Clarity of information disclosed | The information revealed is the diversity of bintangur species in West Kalimantan, which can be used to enrich students' insights and support learning material on biodiversity and their interactions and roles. |
| 5 | Clarity of exploration guidelines | Students can explore the role of the bintangur for society and ecosystems. In addition, students can explore issues related to threats to the bintangur population. |
| 6 | Clarity of the results to be achieved | The existence of learning resources can support students in achieving cognitive, affective, and psychomotor learning outcomes, especially on the material of biodiversity and their interactions and roles. |

The first requirement is clarity regarding the potential availability of objects and the problems raised. The potential studied in this study is the diversity of bintangur species in West Kalimantan. This potential can be a solution to overcome the limited knowledge of students in West Kalimantan about the diversity of bintangur in the province: students and the general public need to be more naive about biodiversity in their area [59]. Therefore, implementing information on the diversity of bintangur species in West

Kalimantan as a learning resource can solve the problem of students' need for knowledge of local biodiversity. Biodiversity-based learning aims to increase students' insight related to biodiversity in their area [19].

The second requirement is compatibility with learning objectives. The study of the diversity of bintangur species in West Kalimantan relates to the material on biodiversity and their interactions and roles, which is part of the biology subject in class X of senior high school. The

learning outcomes of the material on biodiversity and their interactions and roles are “At the end of phase E, students can create solutions to problems based on local, national, or global issues related to understanding biodiversity and their roles” [60]. Based on the results of the literature review results of bintangur species diversity in West Kalimantan that has been carried out, it can be seen that the study has the potential to be used for the learning objectives “Identify the levels of biodiversity” and “Describe Indonesia's biodiversity.” The diversity of bintangur species in West Kalimantan also follows the learning objective “Describe the kingdom of Plantae.” This is based on the very close relationship between biodiversity and knowledge of the classification of organisms [61-63]. Furthermore, the diversity of bintangur species can be implemented in the learning objective “Analyze the interaction of organisms in their ecosystem”, given that bintangur has varied ecological values.

The third requirement is the clarity of targets and their designation. The analysis that has been carried out results in the acquisition of learning objects and subjects. Clarity and coherence between learning objects and subjects are crucial in the requirements of teaching resources [64]. The object analyzed is the study of bintangur species diversity in West Kalimantan, which can be implemented in the material of biodiversity and their interactions and roles. The subject that is the target of the analysis results is students in class X of senior high school.

The fourth requirement is the clarity of information disclosed. The study revealed information on bintangur species diversity in West Kalimantan. This information can be used to broaden students' insight into West Kalimantan's potential related to local biodiversity and support learning material on biodiversity and their interactions and roles.

The fifth requirement is the clarity of exploration guidelines. Students can explore the role of bintangur in the community and ecosystem. Bintangur has various economic and ecological values [8, 12]. In addition, students can explore various issues related to threats to bintangur's existence. Threats to biodiversity in Indonesia are common [65]. Forest areas that serve as habitat for bintangur often experience land conversion [12]. Bintangur is also susceptible to pathogen attacks that can cause wilt [66].

The sixth requirement is clarity of the results to be achieved. Clarity of acquisition is the process and products that can be used and produced from learning by using related learning resources [67]. Studying the potential diversity of bintangur species in West Kalimantan can help students obtain cognitive, affective, and psychomotor learning outcomes. In the mental aspect, students can increase their insight into local biodiversity in West Kalimantan, especially the species diversity of Bintangur, part of the Plantae kingdom. Good learning resources must be able to provide valuable learning experiences so that they can improve students' thinking skills [68]. In the affective aspect, students can foster a sense of caring for biodiversity conservation. Local plant knowledge-based learning can increase individual empathy for the existence of plant species [69]. In the psychomotor aspect, students can present the results of their exploration in the form of reports or other works to be presented and discussed in class. Assessment of psychomotor learning outcomes can be done when students carry out certain activities and reports generated from

activities that have been carried out [70].

Based on the results of the analysis of learning resources, it is known that the literature study of bintangur diversity in West Kalimantan meets the six requirements of learning resources, particularly in the material of biodiversity and their interactions and roles. The development of teaching resources based on research results is expected to support students to understand the material further and develop various skills related to the research results and material [71]. The 27 species of bintangur in West Kalimantan obtained from the literature study can be integrated into the subjects of species-level biodiversity, Indonesian biodiversity, and organism classification. Threats to the existence of bintangur in West Kalimantan relate to preserving Indonesia's biodiversity. The economic value of bintangur species can be associated with biodiversity benefits. The ecological value of bintangur is a suitable topic to be integrated into interactions between ecosystem components.

Conclusion

The conclusion obtained from the literature study is that there are 27 species of bintangur in West Kalimantan. In addition, information on bintangur diversity in West Kalimantan also meets the requirements of learning resources so that it can be used as a biology learning resource on the material of biodiversity and their interactions and roles in class X of senior high school.

References

- [1] Faturrahman, M. A., Fadhilah, A., Nufitasari, N., Filza, I. A., & Fajri, H. (2023). Inventarisasi Varietas Tanaman Puring (*Codiaeum variegatum* (L.) Rumph. ex A. Juss.) di Desa Jeruju Besar Kecamatan Sungai Kakap Kabupaten Kubu Raya. *Bioscientist: Jurnal Ilmiah Biologi*, 11(2), 1818-1832.
- [2] Von Rintelen, K., Arida, E., & Häuser, C. (2017). A Review of Biodiversity-related Issues and Challenges in Megadiverse Indonesia and Other Southeast Asian Countries. *Research Ideas and Outcomes*, 3, e20860.
- [3] Cahyaningsih, R., Brehm, J. M., & Maxted, N. (2021). Setting the Priority Medicinal Plants for Conservation in Indonesia. *Genetic Resources and Crop Evolution*, 68(5), 2019-2050.
- [4] Kumar, A., & Verma, A. K. (2017). Biodiversity Loss and Its Ecological Impact in India. *International Journal on Biological Sciences*, 8(2), 156-160.
- [5] Rawat, U. S., & Agarwal, N. K. (2015). Biodiversity: Concept, Threats and Conservation. *Environment Conservation Journal*, 16(3), 19-28.
- [6] Mathys, A. S., van Vianen, J., Rowland, D., Narulita, S., Palomo, I., Pascual, U., Sutherland, I. J., Ahammad, R., & Sunderland, T. (2023). Participatory Mapping of Ecosystem Services Across a Gradient of Agricultural Intensification in West Kalimantan, Indonesia. *Ecosystems and People*, 19(1), 2174685.
- [7] Zahra, M. A. (2023). *Analisa Vegetasi dan Potensi Jenis Pakan Orangutan Kalimantan (Pongo pygmaeus wurmbii) dan Kelempiau (Hylobates albibarbis) di Stasiun Riset Cabang Panti, Taman Nasional Gunung Palung, Kalimantan Barat* [Undergraduate Thesis].

- Universitas Nasional.
- [8] Chinthu, R. V., Raveendran, P. B., & Ravendraan, M. (2023). A Review on the Genus *Calophyllum* L. (Clusiaceae): A Potential Medicinal Tree Species. *Plant Science Today*, 10(3), 1-5.
- [9] Susanto, D. F., Aparamarta, H. W., Widjaja, A., Firdaus, F., & Gunawan, S. (2019). *Calophyllum inophyllum*: Beneficial Phytochemicals, Their Uses, and Identification. In A. Rao, D. Mans, & L. Rao, *Phytochemicals in Human Health*. Rijeka: IntechOpen.
- [10] Farida, S., Jenie, R. I., & Fakhruddin, N. (2024). *Calophyllum inophyllum*: A Comprehensive Analysis of Its Ethnobotanical, Phytochemical, and Pharmacological Properties. *Majalah Obat Tradisional*, 29(2), 121-142.
- [11] Aminudin, N. I., Ahmad, F., Taher, M., & Zulkifli, R. M. (2016). Incrassamarin A-D: Four New 4-substituted Coumarins from *Calophyllum incrassatum* and Their Biological Activities. *Phytochemistry Letters*, 16, 287-293.
- [12] Yuliastrin, A. (2015). Ancaman Kelestarian Populasi Bintangur (*Calophyllum* spp.) Akibat Alih Fungsi Hutan Lindung di Batam. *SEMIRATA 2015*, 4(1), 612-623.
- [13] Gupta, S., & Gupta, P. (2020). The Genus *Calophyllum*: Review of Ethnomedicinal Uses, Phytochemistry and Pharmacology. In J. Singh, V. Meshram, & M. Gupta, *Bioactive Natural Products in Drug Discovery*. Singapore: Springer Nature Singapore Pte Ltd.
- [14] Jailani, M. S., & Hamid, A. (2016). Pengembangan Sumber Belajar Berbasis Karakter Peserta Didik (Ikhtiar Optimalisasi Proses Pembelajaran Pendidikan Agama Islam (PAI)). *Nadwa: Jurnal Pendidikan Islam*, 10(2), 175-192.
- [15] Anwar, Z., & Wibawa, B. (2019). Development of Learning Resources Based on E-books in *Sasak Alus* Language for Elementary Schools in Lombok. *International Journal of Innovation, Creativity and Change*, 6(8), 36-45.
- [16] Hartanti, R. D., Paidi, P., Aloysius, S., Kuswanto, H., & Rasis, R. (2024). Spice Plants as a Biology Learning Resources Based-education for Sustainable Development. *International Journal of Evaluation and Research in Education (IJERE)*, 13(1), 534-546.
- [17] Faturrahman, M. A., Putri, N. R., Nusantoro, B. P., Novahisa, P., Ayu, N. A. K., & Sandra, K. M. (2023). Studi Literatur: Penggunaan Model PBL terhadap Kemampuan Berpikir Kritis Peserta Didik pada Materi Pencemaran Lingkungan. *Jurnal Biogenerasi*, 8(1), 310-322.
- [18] Faturrahman, M. A., & Ningsih, K. (2023). Studi Literatur: Penerapan Model *Discovery Learning* terhadap Hasil Belajar Peserta Didik pada Materi Klasifikasi Makhluk Hidup. *Journal on Education*, 6(1), 7262-7274.
- [19] Mardiansyah, N., Tinidangen, M., & Rambitan, V. M. M. (2017). Analisis Permasalahan Bahan Ajar Berbasis Biodiversitas Daerah Kalimantan Timur pada Pembelajaran IPA Biologi SMP di Kota Samarinda. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 2(11), 1475-1481.
- [20] Sidiq, U., & Choiri, M. M. (2019). *Metode Penelitian Kualitatif di Bidang Pendidikan*. Ponorogo: CV. Nata Karya.
- [21] Kraus, S., Breier, M., Lim, W. M., Dabić, M., Kumar, S., Kanbach, D., Mukherjee, D., Corvello, V., Piñeiro-Chousa, J., Liguori, E., Palacios-Marqués, D., Schiavone, F., Ferraris, A., Fernandes, C., & Ferreira, J. J. (2022). Literature Reviews as Independent Studies: Guidelines for Academic Practice. *Review of Managerial Science*, 16, 2577-2595.
- [22] Winchester, C. L., & Salji, M. (2016). Writing a Literature Review. *Journal of Clinical Urology*, 9(5), 308-312.
- [23] Post, C., Sarala, R., Gattrell, C., & Prescott, J. E. (2020). Advancing Theory with Review Articles. *Journal of Management Studies*, 57(2), 351-376.
- [24] Snyder, H. (2019). Literature Review as a Research Methodology: An Overview and Guidelines. *Journal of Business Research*, 104, 333-339.
- [25] Yuniati, Y., Handarini, K., & Rahmiati, R. (2024). Studi Pustaka: Ekstraksi Pewarna Alami dari Tanaman di Indonesia. *Bioscientist: Jurnal Ilmiah Biologi*, 12(1), 1099-1111.
- [26] Puspitasari, D. A., & Salamah, Z. (2021). Analisis Hasil Penelitian Biologi sebagai Sumber Belajar Materi Jaringan pada Tumbuhan. *Bioeduca: Journal of Biology Education*, 3(2), 99-111.
- [27] Prabaningrum, A., Hanafi, Y., & Ma'rifah, D. R. (2021). Studi Literatur Tingkat Keanekaragaman Gastropoda sebagai Sumber Belajar Biologi SMA Kelas X pada Materi Keanekaragaman Hayati. *Bioscientist: Jurnal Ilmiah Biologi*, 9(2), 318-325.
- [28] Handayani, N. D., & Moro, H. K. E. P. (2021). Analisis Potensi Hasil Penelitian Etnobotani Tradisi *Kuthomoro* di Makam Giriloyo Imogiri Bantul Yogyakarta sebagai Sumber Belajar Biologi SMA. *Journal of Biology Education*, 4(1), 79-92.
- [29] Suryaningsih, Y. (2018). Ekowisata sebagai Sumber Belajar Biologi dan Strategi untuk Meningkatkan Kepedulian Siswa terhadap Lingkungan. *Bio Educatio*, 3(2), 59-72.
- [30] Karma, S. J., Tanjung, R. H. R., & Maury, H. K. (2021). Pendugaan Cadangan Karbon pada Tegakan Pohon di Kawasan Hutan Lindung Irier (HLI) Kampung Sewan, Distrik Sarmi Timur Kabupaten Sarmi, Papua. *Jurnal Biologi Papua*, 13(2), 97-105.
- [31] Sidiyasa, K. (2015). *Jenis-jenis Pohon Endemik Kalimantan*. Samboja: Balai Penelitian Teknologi Konservasi Sumber Daya Alam.
- [32] Byrne, C., Parnell, J. A. N., & Chayamarit, K. (2018). Systematics of the Thai Calophyllaceae and Hypericaceae with Comments on the Kielmeyeroideae (Clusiaceae). *Thai Forest Bulletin (Botany)*, 46(2), 162-216.
- [33] Atikah, T. D., Rahajoe, J. S., & Kohyama, T. S. (2014). Differentiation in Architectural Properties and Functional Traits of Forest-floor Saplings Among Heath, Peat Swamp, and Mixed Dipterocarp Forests. *Tropics*, 22(4), 157-167.
- [34] Taher, M., Salleh, W. M. N. H. W., Alkhamaiseh, S. I., Ahmad, F., Rezali, M. F., Susanti, D., & Hasan, C. M. (2021). A New Xanthone Dimer and Cytotoxicity from the Stem Bark of *Calophyllum can.* *Zeitschrift für Naturforschung C*, 76(1-2), 87-91.

- [35] Astiani, D., Ekamawanti, H. A., Ekyastuti, W., Widiastuti, T., Tavita, G. E., & Suntoro, M. A. (2021). Tree Species Distribution in Tropical Peatland Forest Along Peat Depth Gradients: Baseline Notes for Peatland Restoration. *Biodiversitas Journal of Biological Diversity*, 22(7), 2571-2578.
- [36] Astiani, D. (2016). Tropical Peatland Tree-species Diversity Altered by Forest Degradation. *Biodiversitas Journal of Biological Diversity*, 17(1), 102-109.
- [37] Dewantara, I., Dadang, M., & Marwanto, M. (2022). Keanekaragaman Tegakan Tembawang Desa Landau Kodah Kecamatan Sekadau Hilir Kabupaten Sekadau. *Jurnal Hutan Lestari*, 10(2), 292-302.
- [38] Prasetyo, B. A., Manurung, T. F., & Ardian, H. (2019). Keanekaragaman Jenis Pohon Penyusun Vegetasi di Hutan Rawa Gambut pada Kawasan Hutan Lindung Gunung Ambawang Kecamatan Kubu Kabupaten Kubu Raya. *Jurnal Hutan Lestari*, 7(3), 1439-1445.
- [39] Tanjung, M., Saputri, R. D., & Tjahjandarie, T. S. (2016). 5,9,11-Trihydroxy-2,2-dimethyl-10-(3'-methyl-2'-butenyl)-3-(2''-methyl-3''-butenyl)pyrano[2,3-a]xanthen-12(2H)-one from the Stem Bark of *Calophyllum pseudomole*. *Molbank*, 2017(4), M961.
- [40] Sudarmono, S. (2018). Biodiversity of Medicinal Plants at Sambas Botanical Garden, West Kalimantan, Indonesia. *The Journal of Tropical Life Science*, 8(2), 116-122.
- [41] Astiani, D., Curran, L. M., Mujiman, M., Ratnasari, D., Salim, R., & Lisnawaty, N. (2018). Edge Effects on Biomass, Growth, and Tree Diversity of a Degraded Peatland in West Kalimantan, Indonesia. *Biodiversitas Journal of Biological Diversity*, 19(1), 272-278.
- [42] Fajriaty, I., Hariyanto, I. H., Andres, A., & Setyaningrum, R. (2018). Skrining Fitokimia dan Analisis Kromatografi Lapis Tipis dari Ekstrak Etanol Daun Bintangur (*Calophyllum soulattri* Burm. F.). *Jurnal Pendidikan Informatika dan Sains*, 7(1), 54-67.
- [43] Tjahjandarie, T. S., Saputri, R. D., & Tanjung, M. (2017). 5,9,11-Trihydroxy-2,2-dimethyl-3-(2-methyl but-3-en-2-yl)pyrano[2,3-1]xanthen-12(2H)-one from the Stem Bark of *Calophyllum tetrapterum* Miq.. *Molbank*, 2017(1), M936.
- [44] Teo, S. P. (2019). *Antibacterials from Plants of the Tropical Rain Forests of Borneo* [Doctoral Thesis]. University College London.
- [45] Hong, T. K. (2018). *Phytochemistry of Calophyllum andersonii and Calophyllum wallichianum and Their Antibacterial Activities* [Master Thesis]. Universiti Putra Malaysia.
- [46] Ashwath, N., Nam, H., & Capareda, S. (2021). Maximizing Energy Recovery from Beauty Leaf Tree (*Calophyllum inophyllum* L.) Oil Seed Press Cake via Pyrolysis. *Energies*, 14(9), 2625.
- [47] Gómez-Verjan, J. C., Rodríguez-Hernández, K. D., & Reyes-Chilpa, R. (2017). Bioactive Coumarins and Xanthenes from *Calophyllum* Genus and Analysis of Their Druglikeness and Toxicological Properties. *Studies in Natural Products Chemistry*, 53, 277-307.
- [48] Putri, A. S., Zuhud, E. A. M., & Siswoyo, S. (2024). Ethnobotany of the Malay Community in East Lingga Sub-district, Lingga District, Riau Island. *Media Konservasi*, 29(2), 318-328.
- [49] Darwo, D. & Bogidarmanti, R. (2016). Prospek Budidaya Bintangur (*Calophyllum soulattri*) untuk Dikembangkan di Lahan Gambut. *Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia*, 2(2), 267-270.
- [50] Aminudin, N. I., Ahmad, F., & Taher, M. (2019). Antibacterial and Antioxidant Activities of Extracts from *Calophyllum ferrugineum* and *Calophyllum incrasatum*. *Malaysian Journal of Analytical Sciences*, 23(4), 637-647.
- [51] Septiana, E., & Simanjuntak, P. (2018). Aktivitas Antioksidan Ekstrak Etanol Kulit Batang *Calophyllum pulcherrimum*, *C. soulattri*, dan *C. teysmannii*. *Buletin Penelitian Tanaman Rempah dan Obat*, 29(2), 59-68.
- [52] Lu, Y. F. (2015). Phytochemical and Antioxidant Studies of *Calophyllum sclerophyllum* [Undergraduate Thesis]. Universiti Tunku Abdul Rahman.
- [53] Wan, M. L. (2018). Phytochemical and Antioxidant Studies of *Calophyllum lanigerum* [Undergraduate Thesis]. Universiti Tunku Abdul Rahman.
- [54] Shanmugapriya, S., Chen, Y., Jothy, S. L., & Sasidharan, S. (2016). *Calophyllum inophyllum*: A Medical Plant with Multiple Curative Values. *Research Journal of Pharmaceutical Biological and Chemical Sciences*, 7(4), 1446-1452.
- [55] Leksono, B., Windyarini, E., Hasnah, T., Rahman, S., & Baral, H. (2018). *Calophyllum inophyllum* for Green Energy and Landscape Restoration: Plant Growth, Biofuel Content, Associate Waste Utilization and Agroforestry Prospect. In *2018 International Conference and Utility Exhibition on Green Energy for Sustainable Development (ICUE)*, 1-7. Institute of Electrical and Electronics Engineers.
- [56] Wan-Azman, W. N. S., Mazlan, N., Bernard, H., Silang, S., Zaini, M. K., & Khan, F. A. A. (2022). Diet Analysis of Sympatric Colobine Monkeys from Bako National Park, Sarawak, Borneo. *Borneo Journal of Resource Science and Technology*, 12(1), 157-165.
- [57] Leksono, B., Sukartiningsih, S., Windyarini, E., Adinugraha, H. A., Artati, Y., Kwon, J., & Baral, H. (2021). Growth Performance of *Calophyllum inophyllum* at a Bioenergy Trial Plot in Bukit Soeharto Research and Education Forest, East Kalimantan. *IOP Conference Series: Earth and Environmental Science*, 749, 012059.
- [58] Susilo, M. J. (2014). Potensi Sumber Belajar Biologi SMA Kelas X Versi Kurikulum 2013 untuk Materi Ekosistem Sawah di Sekitar Gunung Puyuh Pundong Kabupaten Bantul. *Proceeding Biology Education Conference*, 11(1), 1032-1038.
- [59] Niemiller, K. D. K., Davis, M. A., & Niemiller, M. L. (2021). Addressing "Biodiversity Naivety" through Project-based Learning Using iNaturalist. *Journal for Nature Conservation*, 64, 126070.
- [60] Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia (2022). *Capaian Pembelajaran Mata Pelajaran Biologi Fase E-Fase F untuk SMA/MA/Program Paket C*.
- [61] Thiele, K. R., Conix, S., Pyle, R. L., Barik, S. K., Christidis, L., Costello, M. J., Van Dijk, P. P., Kirk, P. Lien, A., Thomson, S. A., Zachos, F. E., Zhang, Z., & Garnett, S. (2021). Towards a Global List of Accepted Species I. Why Taxonomists Sometimes Disagree, and Why This Matters. *Organisms Diversity & Evolution*,

- 21, 615-622.
- [62] Sandall, E. L., Maureaud, A. A., Guralnick, R., McGeoch, M. A., Sica, Y. V., Rogan, M. S., Booher, D. B., Edwards, R., Franz, N., Ingenloff, K., Lucas, M., Marsh, C. J., McGowan, J., Pinkert, S., Ranipeta, A., Uetz, P., Wieczorek, J., & Jetz, W. (2023). A Globally Integrated Structure of Taxonomy to Support Biodiversity Science and Conservation. *Trends in Ecology & Evolution*, 38(12), 1143–1153.
- [63] Costello, M. J. (2020). Taxonomy as the Key to Life. *Megataxa*, 1(2), 105-113.
- [64] Eurika, N., & Hapsari, A. I. (2017). Analisis Potensi Tembakau *Na Oogst* sebagai Sumber Belajar Biologi. *Bioma: Jurnal Biologi dan Pembelajaran Biologi*, 2(2), 11–22.
- [65] Faturrahman, M. A. (2023). Brief Review: Plant Diversity Loss in Indonesia as an Impact of Oil Palm (*Elaeis guineensis* Jacq.) Plantation Expansion. *International Journal of Multidisciplinary Research and Publications*, 6(2), 207–209.
- [66] Wright, P. C., Jimenez, B. O., Rakotonirina, P., Andriananoely, D. H., Shea, A., Ratalata, B., & Razafimahaimodison, J. C. (2020). The Progressive Spread of the Vascular Wilt Like Pathogen of *Calophyllum* Detected in Ranomafana National Park, Madagascar. *Frontiers in Forests and Global Change*, 3, 91.
- [67] Munajah, M., & Susilo, M. J. (2015). Potensi Sumber Belajar Biologi SMA Kelas X Materi Keanekaragaman Tumbuhan Tingkat Tinggi di Kebun Binatang Gembira Loka. *JUPEMASI-PBIO*, 1(2), 184–187.
- [68] Ardiyanto, R., Setiadi, A. E., & Qurbaniah, M. (2024). Lizard and Snakes (Reptiles: Squamata) in Gunung Palung National Park as Biology Learning Resources. *Jurnal Penelitian Pendidikan IPA*, 10(8), 4527-4535.
- [69] Balding, M., & Williams, K. J. H. (2016). Plant Blindness and the Implications for Plant Conservation. *Conservation Biology*, 30(6), 1192-1199.
- [70] Sugiarti, S. (2018). Penilaian Psikomotor Siswa pada Pembelajaran Fisika melalui Model Pembelajaran *Guided Inquiry*. *PASCAL (Journal of Physics and Science Learning)*, 2(1), 78-84.
- [71] Febriyanda, Y., Sunandar, A., & Setiadi, A. E. (2022). Habitat Utilization by Long-tailed Monkeys (*Macaca fascicularis*) in Gunung Palung National Park as a Biology Learning Resource. *Jurnal Penelitian Pendidikan IPA*, 8(2), 2392-2398.