

*Full-Length Research Article***Revealing the Tree Species Diversity within Koto Mahligai Temple Ruin, Muaro Jambi**Rizmoon Nurul Zulkarnaen^{1,2,3*}, Muhammad Rifqi Hariri⁴, Lutfi Rahmaningtiyas⁵, Wahyu Adi Nugroho⁶¹ Research Center for Plant Conservation, Botanic Gardens, and Forestry, National Research and Innovation Agency, Bogor, Indonesia² Faculty of Science, Universiti Brunei Darussalam, Tungku Link, Gadong, Brunei Darussalam³ Innovation Centre for Tropical Sciences, Bogor Raya Permai, Curug, Bogor, Indonesia⁴ Research Center for Biosystematics and Evolution, National Research and Innovation Agency, Bogor, Indonesia⁵ Directorate of Management for Scientific Collection, National Research and Innovation Agency, Bogor, Indonesia⁶ Center of Cultural Preservation Region V, Jambi, Indonesia* Corresponding Author. E-mail address: rizmoon.zulkar@gmail.com**ARTICLE HISTORY:**

Received: 25 April 2023

Peer review completed: 13 July 2023

Received in revised form: 15 August 2023

Accepted: 22 August 2023

KEYWORDS:*Diversity*
Enigmatic species
Koto Mahligai
Native plant
*Sumatra***ABSTRACT**

Koto Mahligai Temple is a cultural heritage site in the Muaro Jambi Regency. Environmental disturbances, especially plant-related ones, are rare at this precious shrine. As a result, plant diversity is still sustained. The research aimed to evaluate the plant diversity and general vegetation condition in the Koto Mahligai Temple. The method used was the comprehensive inventory approach, focusing on woody plants through the census sampling method. Vital data were meticulously collected for each tree, including height, diameter, and morphological characteristics. The result found 246 trees from 26 species in the vicinity, including native and introduced species. Local plants that are infrequently seen in urban areas, such as *Bouea macrophylla*, *Canthiumera robusta*, *Dillenia sumatrana*, *Flacourtia rukam*, and *Semecarpus heterophyllus*, are among these species. The result suggested that the Koto Mahligai Temple could be well developed into a public site for stakeholders interested in studying plant diversity in Muaro Jambi Regency, owing to the variety and distinctiveness of its plants. Furthermore, the cultural significance of these plants is tied to the Koto Mahligai Temple, which attracts tourists. The study emphasizes the need for future strategies that harmonize plant preservation, archaeological exploration, and temple restoration efforts.

© 2023 The Author(s). Published by Department of Forestry, Faculty of Agriculture, University of Lampung. This is an open access article under the CC BY-NC license: <https://creativecommons.org/licenses/by-nc/4.0/>.

1. Introduction

Jambi Province is rich in biological and cultural variety (Pamungkas and Agustiningsih 2018; Tamin et al. 2019). The total forest area in Jambi Province is 2,098,535 ha (Dinas Kehutanan Jambi 2019). The peatland ecosystem is one of the Jambi habitats rich in species. Susanti et al. (2020) believed that peatland vegetation, which includes the habitat around the Koto Mahligai Temple and the Muaro Jambi Temple (Pamungkas and Agustiningsih 2018), would evolve into a distinct and uncommon flora species.

Koto Mahligai Temple is one of the cultural heritage sites in Muaro Jambi Regency (Meilania and Febrianti 2019). This temple is recognized as a National Cultural Heritage Area (Ministerial Decision Number 259/M/2013). The National Cultural Heritage Area of Muara Jambi

has a total area of approximately 3981 ha. Meanwhile, the Koto Mahligai Temple covers about 2 ha. The Koto Mahligai Temple's existence is one of the Sriwijaya Kingdom's legacies and is considered a cultural and monumental heritage of Buddhist culture (Sadzali et al. 2021; Siswanto et al. 2017; Yulianti and Seprina 2022). It is a unique tourist destination because it has a richness of temples and a diverse range of existing plants (Firdaus 2017; Nugraha et al. 2015; Saputra et al. 2016).

Koto Mahligai Temple's management is also targeting temple restoration/excavation shortly. The temple's presence and vegetation are critical to the restoration plan. Temple restoration must be carried out carefully since it tries to reveal hidden historical significance from when the temple was formerly standing (Duranti 1997; Foley and Valenzuela 2005; Parlindungan et al. 2021). Cultural awareness can be gained through language, form, and style (Fisher-Borne et al. 2015; Foley and Valenzuela 2005). In addition, the existence of vegetation of Koto Mahligai Temple can also play a role in supporting efforts to increase the value of green open space in Jambi, where green open space in Jambi has decreased as the population increases, as well as support tourism (Napitupulu et al. 2022; Saputra et al. 2016; Ulfa and Fazriyas 2020).

The plants that comprise the Muaro Jambi Temple Complex, notably Koto Mahligai Temple, are classified as lowland forest flora (Tamin et al. 2019). Tamin et al. (2019) undertook an exploratory study on plant diversity in the Koto Mahligai Temple area that needed to be thoroughly carried out, notably by supplementing sampling sites, resulting in a shortage of information gathered. As a result, this study was carried out to complete the data and information about the richness and diversity of plants in the Koto Mahligai Temple area. Also, the health of trees in the Koto Mahligai Temple area was investigated in this study.

This study aimed to evaluate the diversity of plants and analyze the health of plants in the Koto Mahligai area. The study findings are likely to boost the conservation value of the Koto Mahligai Temple's plants. Furthermore, the results of this study are likely one of the foundations for dealing with harmful plants in the future, increasing the value of comfort and safety.

2. Materials and Methods

2.1. Research Location

The study was conducted in the Muaro Jambi Regency of Jambi Province, specifically within the Koto Mahligai Temple Area, Muaro Jambi Village, Sebo District, and Muaro Jambi (Fig. 1). The Koto Mahligai Temple is 2 ha in size. The research was carried out between November 2021 and July 2022.

2.2. Tree Inventory, Species Identification, and Data Analysis

We used the complete explorative approach for woody plants to inventory the plants at Koto Mahligai Temple (Mueller-Dombois and Ellenbergh 2016; Rugayah et al. 2004), as also implemented by Hidayat and Kurniawati (2021). Species, family, native area distribution, and IUCN status are among the observable variables. Furthermore, we collected plant materials as specimen vouchers in the procedures RBGE (2017), particularly for species we could not identify in the field. Flora of Java Vols. I-III (Backer and Bakhuizen van den Brink 1963; 1965; 1968) and Flora Malesiana Series I Vol. 17(2) (Berg and Corner 2005) were relied upon to determine plant species based on their morphological features. To confirm the accepted species names and native

distribution of each plant, we used the Plants of The World Online website (POWO 2023). Furthermore, we used the IUCN website to determine the plants' threatened status (IUCN 2023). The data were analyzed descriptively based on the species composition, native distribution, and IUCN status of the observed plants.

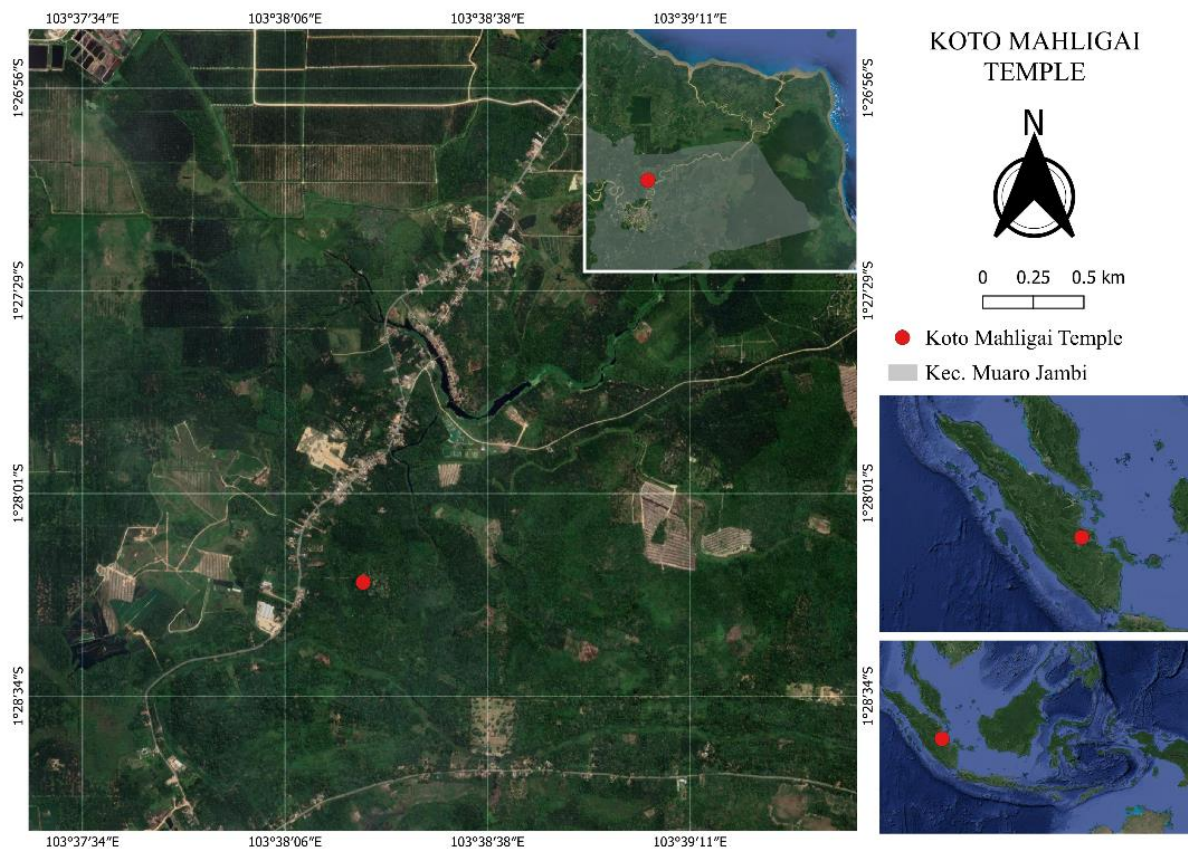


Fig. 1. Research location.

3. Results and Discussion

3.1. Tree Species Diversity

The survey of plants that comprise the Koto Mahligai Temple area yielded 248 individuals representing 27 species from 16 groups (**Table 1**). Table 1 also includes information on the number of individuals, namely, *Peronema canescens* (64 individuals), *Dimocarpus longan* (59 individuals), *Lansium domesticum* (25), *Tetrameles nudiflora* (25), and *Sterculia gilva* (19) have the most. In the meantime, only one individual was discovered in nine species, including *Aglaia* sp., *Aporosa* sp., *Averrhoa carambola*, *Averrhoa bilimbi*, *Dracontomelon dao*, *Dysoxylum densiflorum*, *Ficus ardisioides*, *Nauclea subdita*, and *Vitex pinnata*. Local plants that are infrequently seen in urban areas, such as *Bouea macrophylla*, *Canthiumera robusta*, *Dillenia sumatrana*, *Flacourtia rukam*, and *Semecarpus heterophyllus*, are among these species.

According to earlier research, *Lansium domesticum* and *Peronema canescens* predominate outside the Koto Mahligai Temple area (Tamin et al. 2019). The findings of this study are significantly associated with the temple's proximity to the villagers, as evidenced by the abundance of fruit trees and plants widely used as firewood, such as *Peronema canescens*. Nonetheless, Susanti et al. (2020) recorded roughly 65 species of constituent plants in the Muaro Jambi Temple complex (shared with Koto Mahligai Temple in the same complex area), with 52

species being woody trees. Among the ten woody plants found outside Koto Mahligai Temple are *Archidendron pauciflorum*, *Averrhoa bilimbi*, *Ficus variegata*, *Flacourtia rukam*, *Lagerstroemia speciosa*, *Lansium domesticum*, *Peronema canescens*, *Radermachera glandulosa*, *Spondias dulcis*, and *Vitex pinnata*. The vast majority of these plants develop quickly. Hidayat (2012) described these plants as pioneer species with low wood strength and endurance.

Table 1. List of species diversity in Koto Mahligai Temple

No	Species name	Local name	Family	Total Individual
1	<i>Aglaia</i> sp.	Langsatan	Meliaceae	1
2	<i>Aporosa</i> sp.	Rambai hutan	Phyllanthaceae	1
3	<i>Archidendron pauciflorum</i>	Jering	Fabaceae	2
4	<i>Averrhoa bilimbi</i>	Belimbing wuluh	Oxalidaceae	1
5	<i>Averrhoa carambola</i>	Belimbing	Oxalidaceae	1
6	<i>Bouea macrophylla</i> *	Gandaria/Raman	Anacardiaceae	2
7	<i>Canthiumera robusta</i>	Kopi hijau	Rubiaceae	2
8	<i>Dillenia sumatrana</i> *	Simpur	Dilleniaceae	2
9	<i>Dimocarpus longan</i> *	Bedaro	Sapindaceae	59
10	<i>Dracontomelon dao</i>	Dao	Anacardiaceae	1
11	<i>Epicharis densiflora</i> *	Tipis kulit	Meliaceae	1
12	<i>Ficus ardisioides</i>	Aro	Moraceae	1
13	<i>Ficus variegata</i> *	Klebuk	Moraceae	6
14	<i>Flacourtia rukam</i> *	Rukam	Salicaceae	3
15	<i>Lagerstroemia speciosa</i> *	Bungur	Lythraceae	3
16	<i>Lansium domesticum</i> *	Duku	Meliaceae	25
17	<i>Nauclea subdita</i> *	Bengkai	Rubiaceae	1
18	<i>Peronema canescens</i> *	Sungkai	Lamiaceae	64
19	<i>Planchonia valida</i> *	Putat lembek	Lechytidaceae	6
20	<i>Pometia pinnata</i>	Matoa	Sapindaceae	4
21	<i>Radermachera quadripinnata</i> *	Banai-banai	Bignoniaceae	9
22	<i>Semecarpus heterophyllus</i> *	Rengas manuk	Anacardiaceae	4
23	<i>Spondias pinnata</i>	Kedondong	Anacardiaceae	2
24	<i>Sterculia gilva</i>	Belanti	Malvaceae	19
25	<i>Tetrameles nudiflora</i> *	Kundur	Tetramelaceae	25
26	<i>Vitex pinnata</i> *	Leban	Lamiaceae	1
Total				246

Note: *native distribution to Sumatra.

A detailed study of the plants at Koto Mahligai Temple reveals an iconic and culturally significant plant known as kundur (*Tetrameles nudiflora*) (Fig. 2). Through interviews with the Head of BPCB Jambi (*Balai Pelestarian Cagar Budaya Provinsi Jambi*), this plant has a strong historical association with Buddhist culture and will be kept as part of temple renovation plans to improve the temple's appeal. There are 25 documented kundur specimens with an older age category and an average diameter of 90-100 cm. Reproduction as seed stock is critical to the survival of this species and other conservation concerns. Interestingly, the kundur plant is unique to the Koto Mahligai Temple area since we spotted some growing in Koto Mahligai and only one tree in the Muaro Jambi Temple area.

Dapadeda et al. (2017) explained that temperature substantially influences kundur growth, with higher temperatures lowering their survival. Pumijumnong and Buajan (2013) said that kundur is most active when rainfall reaches its maximum. Furthermore, Koto Mahligai Temple, being a tourist destination, is responsible for safeguarding tourists from tree falls. It is an important

concern, in addition to preserving cultural values in the Koto Mahligai Temple area. Kundur, which has the dominant layer or is the highest tree within Koto Mahligai Temple, requires diligent monitoring to ensure its health, particularly in the stems (Martiansyah et al. 2022; Tsani and Safe'i 2018; Zulkarnaen et al. 2021). According to Martiansyah et al. (2022) and Zulkarnaen et al. (2021), tree damage frequently occurs in the stem and crown. Tsani and Safe'i (2018) also discovered that the dominance of the location of damage in stems was also detected in trees in the Way Kambas National Park Training Center. The management of Koto Mahligai Temple must be aware of the indicators of stem damage, since the roots of some trees are clasping into the remnants of the temple, and address them as soon as possible to avoid any casualties, either the staff or the restored temple (Fig. 3).

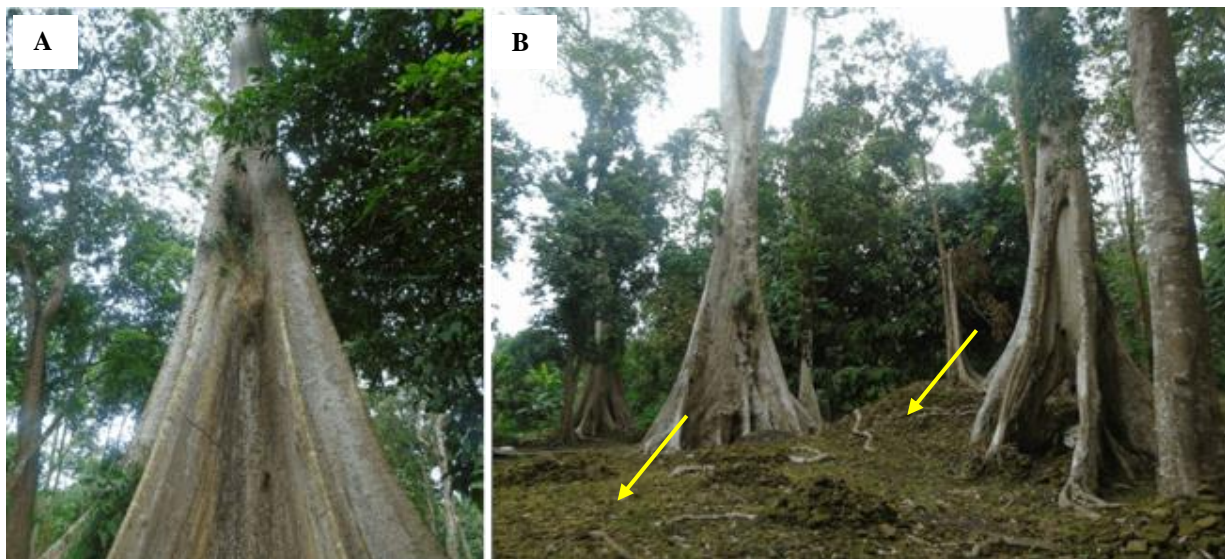


Fig. 2. Kundur (*Tetrameles nudiflora*): (a) an individual of kundur and (b) temple ruins at the kundur root area (yellow sign).

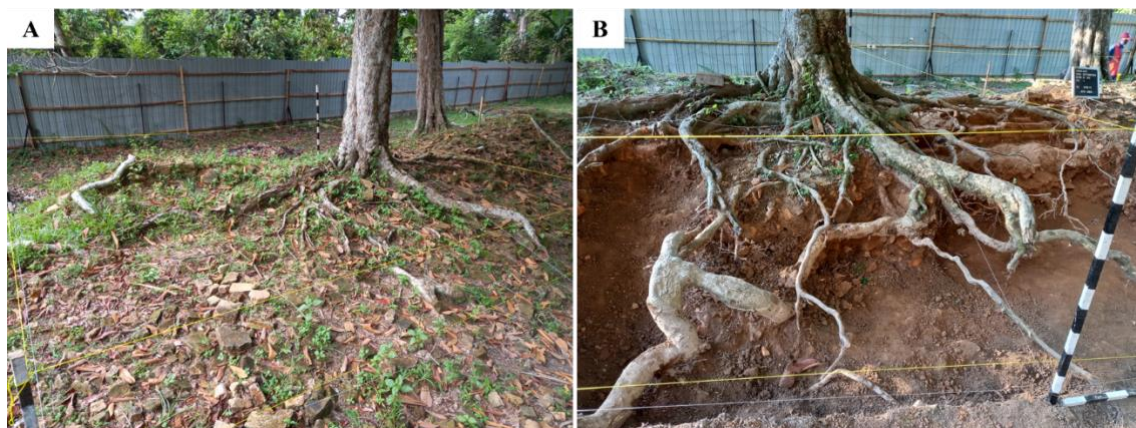


Fig. 3. Part of Koto Mahligai Temple ruins where the roots of *Dimocarpus longan* are clasping into some remnants: (a) before excavation and (b) after partial excavation.

3.2. Enigmatic and Potential Tree within Koto Mahligai Temple

Six species of ornamental plants, each characterized by their distinctive features, have been identified at Koto Mahligai Temple. These species, including sungkai (*Peronema canescens*), aro (*Ficus ardisioides*), klebuk (*Ficus variegata*), rengas manuk (*Semecarpus heterophyllus*), kundur

(*Tetrameles nudiflora*), and belanti (*Sterculia gilva*), hold promising potential for various applications and purposes within the temple's surroundings.

Sungkai (*Peronema canescens*) belongs to the Lamiaceae family (formerly Verbenaceae), that grows abundantly at Koto Mahligai Temple. This species is indigenous to Sumatra, and its natural range extends from the Thai Peninsula to West Malesia (**Fig. 4a**) (POWO 2023). Sungkai is a species with slowing growth with particular benefits. It can be regenerated through vegetatively. Therefore, it is independent of the flowering and fruiting seasons (Nugroho and Istikowati 2020). According to Olmstead (2013), verbenaceous trees are stubborn survivors, even when cultivated far from their ecological optimum, despite having crooked stems and low development. Sungkai is typically propagated through cuttings rather than seeds since it is simple to cultivate and independent of the fruiting season. In general, the availability of sungkai cuttings at a particular location is deemed to be more important than the quality of specific trees as cutting sources. Sungkai wood is predominantly used for furniture (Nugroho and Istikowati 2020; Sahwalita 2017; Samboro et al. 2017). Residents cut down small trees (diameter of 10 cm) to use them as support for roofs in South Kalimantan (Puspita et al. 2020). Additionally, it has found applications in cabinetry, molding, veneer, plywood, and handicrafts. The rising need for sungkai wood as a raw material is driven by the increasing demand for products made from sungkai wood (Farizan et al. 2018).

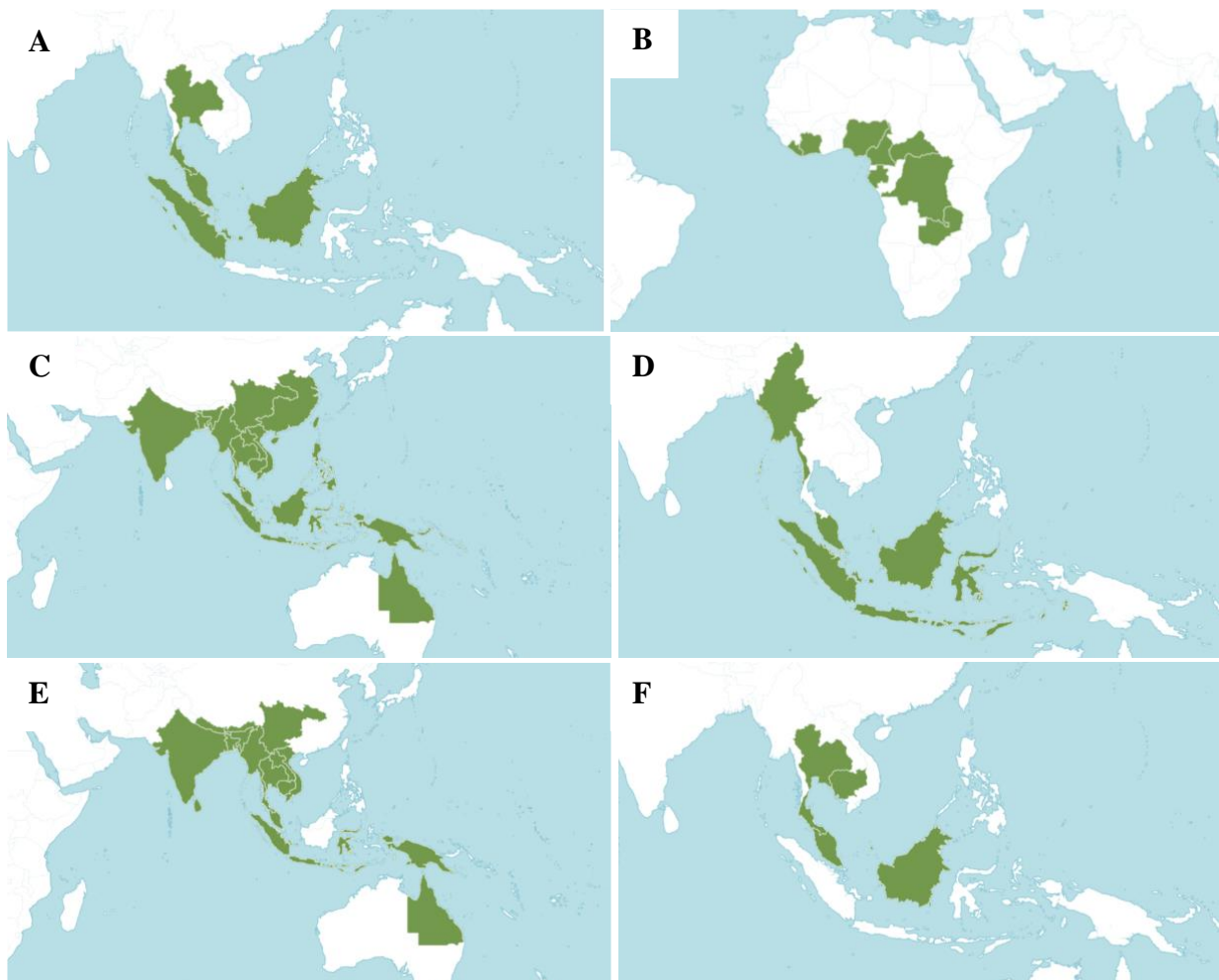


Fig. 4. Native distribution of *Peronema canescens* (A), *Ficus ardisioides* (B), *Ficus variegata* (C), *Semecarpus heterophyllus* (D), *Tetrameles nudiflora* (E), and *Sterculia gilva* (F) (POWO 2023).

Koto Mahligai Temple has two Moraceae members, namely aro (*Ficus ardisioides*) and klebuk (*Ficus variegata*) (Fig. 4b-c). Surprisingly, the number of klebuk was more than that of aro. This tendency was made possible by the differences in the original distribution of the two species, which caused aro to adapt more slowly, and the absence of pollinators to aid in its generative reproduction (Fig. 4b) (Ebika et al. 2018; POWO 2023). Several figs, such as *F. racemosa* and *F. variegata*, are widespread in numerous geographical regions (Berg and Corner 2005). This species can grow to at least 20 m and is distinguished by its red berries. Segments of pale green or yellow fruit were among the mature red fruit. The pale green group known as gall fruit is believed to correlate with the evolution of monkeys' eyesight (Berg and Corner 2005). In addition to its conservation value, this species can play a significant role in land restoration, as it is a pioneer species abundant in natural forests following the fire (Hendrayana et al. 2021).

Rengas manuk (*Semecarpus heterophyllus*) is an Anacardiaceae belonging to the Koto Mahligai Temple, which is indigenous to Andaman and Nicobar Islands to West and Central Malesia (Fig. 4d) (POWO 2023). This species consists of two trees and is classified as near-threatened (NT), meaning that if the disturbance continues, this species will become extinct in the wild (Ganesan 2021). When exposed to water, the resinous sap of Anacardiaceae hardens and turns black. Several species in the family, particularly *Toxicodendron* and *Semecarpus*, can produce severe dermatitis after contact, particularly in those sensitized to plants by long-term exposure (LeCoz et al. 2011). Thus, the existence of this species in the area must be considered by adding information to warn visitors and cultural heritage employees.

Kundur (*Tetrameles nudiflora*) is a Tetramelaceae plant present in the Koto Mahligai Temple. This species is native to Sumatra, and its natural range spans from South Yunnan, China, to Tropical Asia and North Queensland, Australia (Fig. 4e) (POWO 2023). The roots of huge *T. nudiflora* are typically regarded as damaging to archaeological constructions (André et al. 2014; Caneva et al. 2016). Nonetheless, many artistic masterpieces are still engulfed by vegetation and should not be eliminated based on a misguided understanding of the tree's function. The fact that individual trees pose a local hazard to archaeological sites should not obscure the protective function of the canopy as a whole. Even though forest ecosystems are recognized as buffers against coastal and river erosion (Mazda et al. 2002; Zaimes et al. 2004), their protective function at heritage sites remains unacknowledged.

Belanti (*Sterculia gilva*) is a member of the Malvaceae family and one of the dominant species in the Koto Mahligai Temple. This species is native to Sumatra, and its natural range stretches from southern Indo-China to western Malesia (Fig. 4f) (POWO 2023). *Sterculia gilva* is a tree with a maximum height of 40 m that thrives in lowland swamp and peat-swamp forests. As a deciduous tree that produces fruit and flowers, wood is used as a building material (Lidayanti et al. 2016). *Sterculia gilva* seedlings grown from seeds have a high survival rate, allowing for more effective generative reproduction and the development of viable offspring.

3.3. Recommendation for Tree Conservation during Excavation

The Koto Mahligai Temple, situated along the major road in Jambi Regency, is one of the cultural heritages with green open spaces that must be preserved. The ecological and cultural significance of the temple grounds is increased by the presence of several plant species. The presence of this complex is crucial for the preservation of both the temple area and the plant species that comprise it. It could be caused that a region with several plant species can provide a home for

numerous animal species (Batoro and Lutfi 2017; Canády and Mošansky 2017; Meltriana et al. 2018). In addition to its ecological, socio-cultural, architectural, and economic roles, a green open space with a clear legal standing should also support educational or research activities for the community.

Koto Mahligai Temple has not been fully utilized as a public site for studying the flora and fauna diversity of the Jambi Regency. Koto Mahligai Temple requires more care to provide the community with educational opportunities to learn about the surrounding biodiversity. Historical tour activities coupled with an introduction to the various species of plants at the Koto Mahligai Temple can be activities that attract the interest of Jambi Regency residents. The recognition of the buffering function of forest cover as an ecosystem service at heritage sites should motivate stakeholders to incorporate integrated management of the plant cover into their conservation strategy (André et al. 2014; Nugraha et al. 2015). Further research on the flora and fauna biodiversity in the Koto Mahligai Temple region is required to ensure the integrity of the obtained data, and community perception can be an added value to visualize their comfort and preferences, as previously reported by Sulistyana et al. (2017) in Metro City, Lampung. Moreover, the obtained biodiversity data might be the foundation for creating cultural heritage regions based on ecotourism (Saputra et al. 2016).

4. Conclusions

The presence of flora within Koto Mahligai Temple is a natural resource that must be appropriately preserved. The study showed 246 trees from 26 species (native and introduced species) in the area. *Bouea macrophylla*, *Canthiumera robusta*, *Dillenia sumatrana*, *Flacourtia rukam*, and *Semecarpus heterophyllus* are urban rarities. Due to its diverse plants, the Koto Mahligai Temple could be an excellent public location for stakeholders studying plant diversity in the Muaro Jambi Regency. Furthermore, the cultural significance of these plants is tied to the Koto Mahligai Temple, which attracts tourists. The study's future suggestions include the hope that interested parties reach an agreement between the goals of plant protection and the importance of excavation and temple repair.

Acknowledgments

We appreciate the Chief of Jambi Cultural Heritage Preservation Center's permission to conduct this research. We also acknowledge the support from the Head of Research Center for Plant Conservation, Botanic Gardens, and Forestry, National Research and Innovation Agency. We also thank everyone who helped with the research, including the staff of BPCB Jambi. We would also like to express our gratitude to the Woody Guest House and *Kopi Dusun* for supporting the data collection procedure and inspiring our study. We also want to thank Zakaria Al Anshori, Arifin Surya Dwipa Irsyam, Peniwidiyanti, and Harto for their discussions and outstanding help with the plant species identification.

References

André, M. F., Vautier, F., Voldoire, O., and Roussel, E. 2014. Accelerated Stone Deterioration Induced by Forest Clearance around the Angkor Temples. *Science of The Total Environment*

- 493: 98–108. DOI: [10.1016/j.scitotenv.2014.05.141](https://doi.org/10.1016/j.scitotenv.2014.05.141)
- Backer, C. A., and Bakhuizen van den Brink, R. C. 1963. *Flora of Java (Vol. I)*. Groningen, The Netherlands: Wolters-Noordhoff N.V.
- Backer, C. A., and Bakhuizen van den Brink, R. C. 1965. *Flora of Java (Vol. II)*. Groningen, The Netherlands: Wolters-Noordhoff N.V.
- Backer, C. A., and Bakhuizen van den Brink, R. C. 1968. *Flora of Java (Vol. III)*. Groningen, The Netherlands: Wolters-Noordhoff N.V.
- Batoro, J., and Lutfi, I. 2019. The Perceptions of Sacred Site (Petren) and Plant Diversity in Malang, East Java, Indonesia. *International Journal of Basic and Applied Sciences JBAS-IJENS* 19(6): 9–10. DOI: [10.3329/ajmbr.v6i3.49790](https://doi.org/10.3329/ajmbr.v6i3.49790)
- Berg, C. C., and Corner, E. J. H. 2005. Moraceae: Ficeae. *Flora Malesiana - Series 1. Spermatophyta* 17(2): 1–702.
- Canády, A., and Mošanský, L. 2017. Public Cemetery as a Biodiversity Hotspot for Birds and Mammals in the Urban Environment of Kosice City (Slovakia). *Zoology and Ecology* 27(3-4): 185–195. DOI: [10.1080/21658005.2017.1366024](https://doi.org/10.1080/21658005.2017.1366024)
- Caneva, G., Bartoli, F., Savo, V., Futagami, Y., and Strona, G. 2016. Combining Statistical Tools and Ecological Assessments in the Study of Biodeterioration Patterns of Stone Temples in Angkor (Cambodia). *Scientific Reports* 6(1): 32601. DOI: [10.1038/srep32601](https://doi.org/10.1038/srep32601)
- Dapadeda, F., Zuhud, E. A., and Hikmat, A. 2017. Species Association of Corpse Storage Trees in Laiwangi Wanggameti National Park, East Nusa Tenggara. *Media Konservasi* 22(3): 220–9. DOI: [10.29244/medkon.22.3.220-229](https://doi.org/10.29244/medkon.22.3.220-229)
- Dinas Kehutanan Jambi. 2019. *Luas Kawasan Hutan (Hektar), 2017-2019*. Retrieved from <https://jambi.bps.go.id/indicator/60/442/1/luas-kawasan-hutan.html>. Accessed on 27 March 2023.
- Duranti, A. 1997. Universal and Culture-Specific Properties of Greetings. *Journal of Linguistic Anthropology* 7(1): 63–97.
- Ebika, S. N., Morgan, D., Sanz, C., and Harris, D. J. 2018. Ficus Species in the Sangha Trinational, Central Africa. *Edinburgh Journal of Botany* 75(3): 377–420. DOI: [10.1017/s0960428618000173](https://doi.org/10.1017/s0960428618000173)
- Farizan, N. A., Catherine, B. and Sahri, M.H. 2018. Tensile Shear Strength of Natural Wood Decorative Plywood from Lesser Known Sungkai (*Peronema canescens*) Tree. *IOP Conference Series: Materials Science and Engineering* 368: 012045. DOI: [10.1088/1757-899x/368/1/012045](https://doi.org/10.1088/1757-899x/368/1/012045)
- Fisher-Borne, M., Cain, J. M., and Martin, S. L. 2015. From Mastery to Accountability: Cultural Humility as an Alternative to Cultural Competence. *Social Work Education* 34(2): 165–181. DOI: [10.1080/02615479.2014.977244](https://doi.org/10.1080/02615479.2014.977244)
- Foley, D., and Valenzuela, A. 2005. *Critical Ethnography. The Sage Handbook of Qualitative Research*. SAGE Publications. New York, US. 217–234p.
- Ganesan, S. K. 2021. *Semecarpus heterophyllus*. *The IUCN Red List of Threatened Species 2021*: e.T194361953A194361965. DOI: [10.2305/iucn.uk.2021-2.rlts.t194361953a194361965.en](https://doi.org/10.2305/iucn.uk.2021-2.rlts.t194361953a194361965.en)
- Hendrayana, Y., Supartono, T., Adhya, I., Ismail, A. Y., and Kosasih, D. 2021. Distribution and Association of *Ficus* spp in the Shrubs Area of Gunung Ciremai National Park Indonesia. *IOP Conference Series: Earth and Environmental Science* 819: 012078. DOI: [10.1088/1755-1315/819/1/012078](https://doi.org/10.1088/1755-1315/819/1/012078)
- Hidayat, I. W., and Kurniawati, F. 2021. Botanical Exploration and Conservation in Pasir Banteng

- and Pasir Pogor, Gunung Gede Pangrango National Park. *Jurnal Sylva Lestari* 9(3): 488–502. DOI: [10.23960/jsl.v9i3.540](https://doi.org/10.23960/jsl.v9i3.540)
- Hidayat, R. 2012. *Perbaikan Kualitas Sifat Mekanis Jenis Kayu Cepat Tumbuh Jabon (Anthocephalus cadamba (Roxb.)) Miq. dengan Metode Pemadatan*. Fakultas Kehutanan IPB University. Bogor.
- IUCN. 2023. The IUCN Red List of Threatened Species. Version 2022-2. <https://www.iucnredlist.org>. Accessed on 21 March 2023.
- LeCoz, C.J., Ducombs, G., and Paulsen, E. 2011. *Plants and Plant Products*. In: Johansen, J., Frosch, P., Lepoittevin, JP. (eds) Contact Dermatitis. Springer, Berlin, Heidelberg. DOI: [10.1007/978-3-642-03827-3_46](https://doi.org/10.1007/978-3-642-03827-3_46)
- Lisdayanti, L., Hikmat, A., and Istomo, I. 2016. Komposisi Flora dan Keragaman Tumbuhan di Hutan Rawa Musiman, Rimbo Tujuh Danau Riau. *Jurnal Penelitian Hutan dan Konservasi Alam* 13(1): 15–28. DOI: [10.20886/jphka.2016.13.1.15-28](https://doi.org/10.20886/jphka.2016.13.1.15-28)
- Martiansyah, I., Zulkarnaen, R. N., Hariri, M. R., Hutabarat, P. W. K., and Wardani, F. F. 2022. Tree Health Monitoring of Risky Trees in the Hotel Open Space: A Case Study in Rancamaya, Bogor. *Jurnal Sylva Lestari* 10(2): 180–201. DOI: [10.23960/jsl.v10i2.570](https://doi.org/10.23960/jsl.v10i2.570)
- Mazda, Y., Magi, M., Nanao, H., Kogo, M., Miyagi, T., Kanazawa, N., and Kobashi, D. 2002. Coastal Erosion Due to Long-Term Human Impact on Mangrove Forests. *Wetlands Ecology and Management* 10: 1–9. DOI: [10.1023/a:1014343017416](https://doi.org/10.1023/a:1014343017416)
- Meilania, M., and Febrianti, H. 2019. Pelestarian Candi Muaro Jambi sebagai Benda Cagar Budaya dan Pariwisata di Provinsi Jambi. *Journal V-Tech* 2(1): 99–109.
- Meltriana, A., Mardiasuti, A., and Mulyani, Y. A. 2018. Urban Cemeteries as Habitat for Birds. *IOP Conference Series: Earth and Environmental Science* 179: 012041. DOI: [10.1088/1755-1315/179/1/012041](https://doi.org/10.1088/1755-1315/179/1/012041)
- Mueller-Dombois, D., and Ellenbergh, H. 2016. *Ekologi Vegetasi: Tujuan dan Metode. Alih Bahasa oleh Kuswata Kartawinata dan Rochadi Abdulhadi*. LIPI Press. Jakarta.
- Napitupulu, D. M., Muchlis, F., and Adriansyah, E. 2022. Analysis of Provision of Green Open Space in Jambi City. *International Journal of Research in Vocational Studies* 2(3): 78–82. DOI: [10.53893/ijrvocas.v2i3.148](https://doi.org/10.53893/ijrvocas.v2i3.148)
- Nugraha, B., Banuwa, I. S., and Widagdo, S. 2015. Perencanaan Lanskap Ekowisata Hutan Mangrove di Pantai Sari Ringgung Desa Sidodadi Kecamatan Padang Cermin Kabupaten Pesawaran. *Jurnal Sylva Lestari* 3(2): 53–66. DOI: [10.23960/jsl2353-66](https://doi.org/10.23960/jsl2353-66)
- Nugroho, A., and Istikowati, W. T. 2020. Characteristics and Performance of Charcoal Briquette from the Sawdust of Sungkai (*Peronema canescens* Jack.). *IOP Conference Series: Earth and Environmental Science* 473(1): 012098. DOI: [10.1088/1755-1315/473/1/012098](https://doi.org/10.1088/1755-1315/473/1/012098)
- Olmstead, R. G. 2013. Phylogeny and Biogeography in Solanaceae, Verbenaceae and Bignoniaceae: A Comparison of Continental and Intercontinental Diversification Patterns. *Botanical Journal of the Linnean Society* 171(1): 80–102. DOI: [10.1111/j.1095-8339.2012.01306.x](https://doi.org/10.1111/j.1095-8339.2012.01306.x)
- Pamungkas, S., and Agustiningih, N. 2018. Candi Muaro Jambi: Kajian Cerita Rakyat, Arkeologi, dan Pariwisata. *Istoria: Jurnal Ilmiah Pendidikan Sejarah Universitas Batanghari* 2(2): 49–62. DOI: [10.33087/istoria.v2i2.40](https://doi.org/10.33087/istoria.v2i2.40)
- Parlindungan, H. H., Sukwika, T., and Manurung, H. 2021. Prambanan Temple Tourist Destination Development in Indonesia as World Cultural Heritage. *European Journal of Science, Innovation and Technology* 1(3): 39–56.

- POWO. 2023. *Plants of the World Online*. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet. <http://www.plantsoftheworldonline.org>. Accessed on 21 March 2023.
- Pumijumnong, N. and Buajan, S. 2013. Seasonal Cambial Activity of Five Tropical Tree Species in Central Thailand. *Trees* 27: 409–417. DOI: [10.1007/s00468-012-0794-4](https://doi.org/10.1007/s00468-012-0794-4)
- Puspita, D., Notoedarmo, S., and Fauzi, M.R. 2020. Studi Etnobotani di Kawasan Kars Bukit Bulan untuk Mendukung Studi Arkeologi. *Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan* 10(2): 270–283. DOI: [10.29244/jpsl.10.2.270-283](https://doi.org/10.29244/jpsl.10.2.270-283)
- RBGE. 2017. *Guide to Collecting Herbarium Specimens in the Field*. Royal Botanic Garden Edinburgh, Ashford Colour Press, Edinburgh, UK.
- Republik Indonesia. 2013. *Surat Keputusan Menteri Pendidikan dan Kebudayaan Republik Indonesia No. 259/M/2013 tentang Penetapan Satuan Ruang Geografis Muarajambi Sebagai Kawasan Cagar Budaya Peringkat Nasional*. Keputusan Menteri Pendidikan dan Kebudayaan Republik Indonesia. Jakarta, Indonesia.
- Rugayah, R. A., Windadri, F. I., and Hidayat, A. 2004. *Pengumpulan Data Taksonomi*. In: Rugayah, Widjaja, E. A., Praptiwi (Eds.) *Pedoman Pengumpulan Data Keanekaragaman Flora*. Pusat Penelitian Biologi-LIPI, Bogor, Indonesia, 5–24.
- Sadzali, A. M., Resiyani, W., and Fitrah, Y. 2021. The Civilization of Batanghari River: The Relationship between Dharmasraya Temple and Muarajambi Ancient Malay Period in Religious Perspective. *Proceeding International Conference on Malay Identity 2*: 7–14.
- Sahwalita, N. F. N. 2017. The Effect of Cutting Material on the Propagation Success of Sungkai (*Peronema canescen* Jack.) and Cutting Potential Provided by Hedge Orchard. *Jurnal Perbenihan Tanaman Hutan* 5(1): 23–34. DOI: [10.20886/bptph.2017.5.1.23-34](https://doi.org/10.20886/bptph.2017.5.1.23-34)
- Samboro, M. A., Sriwarno, A. B., and Djati, I. D. 2017. Material Efficiency of Wood Waste Industries to Design by Using Laser Cutting Technology (Pine, Sungkai, Sengon, and Kamper Wood). In *1st International Conference on Art, Craft, Culture and Design 2017*. Bandung Institute of Technology.
- Saputra, A. D., Indriyanto, I., and Duryat, D. 2016. Komposisi, Struktur, dan Keanekaragaman Jenis Vegetasi di Jalur Wisata Air Terjun Wiyono Atas Taman Hutan Raya Wan Abdul Rachman Provinsi Lampung. *Jurnal Sylva Lestari* 4(3): 83–96. DOI: [10.23960/jsl3483-96](https://doi.org/10.23960/jsl3483-96)
- Siswanto, A., Farida., and Sedoputra, H.W. 2017. Pariwisata dan Pelestarian: Suatu Pendekatan Untuk Mencegah Kerusakan pada Bangunan Candi Masa Sriwijaya. Paper Presented at the Seminar Ikatan Peneliti Lingkungan Binaan Indonesia (IPLBI), Cirebon, Indonesia.
- Sulistiyana, M. I. C. D., Yuwono, S. B., and Rusita, R. 2017. Kenyamanan Hutan Kota Linara Berbasis Kerapatan Vegetasi, Iklim Mikro dan Persepsi Masyarakat di Kota Metro. *Jurnal Sylva Lestari* 5(2): 78–87. DOI: [10.23960/jsl2578-87](https://doi.org/10.23960/jsl2578-87)
- Susanti, T., Musyaddad, K., Oryza, D., Utami, W., and Ash, M. A. 2020. Tumbuhan Khas di Kawasan Candi Muaro Jambi dalam Kajian Etnobotani dan Potensi Ekonomi. *Al-Kaunyah: Jurnal Biologi* 13(2): 192–208. DOI: [10.15408/kaunyah.v13i1.13348](https://doi.org/10.15408/kaunyah.v13i1.13348)
- Tamin, R.P., Puri, S.R. and Hardiyanti, R.A. 2019. Exploration of Tree Species in Muaro Jambi Temple Complex. *Media Konservasi* 24(3): 245–251. DOI: [10.29244/medkon.24.3.245-251](https://doi.org/10.29244/medkon.24.3.245-251)
- Tsani, M. K., and Safe'i, R. 2018. Identifikasi Tingkat Kerusakan Tegakan pada Kawasan Pusat Pelatihan Gajah Taman Nasional Way Kambas. *Jurnal Hutan Tropis* 5(3): 215–221. DOI: [10.20527/jht.v5i3.4788](https://doi.org/10.20527/jht.v5i3.4788)
- Ulfa, M., and Fazriyas, F. 2020. Public Green Open Space Development in Jambi City Based on

- Population and Oxygen Needs. *Jurnal Sylva Lestari* 8(3): 366–377. DOI: [10.23960/jsl38366-377](https://doi.org/10.23960/jsl38366-377)
- Yulianti, N., and Seprina, R. 2022. Pemanfaatan Situs Candi Muaro Jambi sebagai Sumber Belajar Bagi Mahasiswa Pendidikan Sejarah Universitas Jambi. *KRINOK: Jurnal Pendidikan Sejarah dan Sejarah* 1(2): 141–155. DOI: [10.22437/krinok.v1i2.18422](https://doi.org/10.22437/krinok.v1i2.18422)
- Zaimes, G. N., Schultz, R. C., and Isenhardt, T. M. 2004. Stream Bank Erosion Adjacent to Riparian Forest Buffers, Row-Crop Fields, and Continuously-Grazed Pastures along Bear Creek in Central Iowa. *Journal of Soil and Water Conservation* 59(1): 19–27.
- Zulkarnaen, R. N., Wardani, F. F., Hutabarat, P. W. K., Martiansyah, I., and Hariri, M. R. 2021. Tree Health Assessment of Lauraceae Collections in Bogor Botanic Gardens using Forest Health Monitoring Method. *Jurnal Sylva Lestari* 9(3): 411–423. DOI: [10.23960/jsl.v9i3.527](https://doi.org/10.23960/jsl.v9i3.527)