

# B1(17)

*by* Tri Mulyaningsih

---

**Submission date:** 05-Apr-2023 12:26AM (UTC-0500)

**Submission ID:** 2056358695

**File name:** Lamp.\_B\_17.pdf (2.37M)

**Word count:** 6468

**Character count:** 34812

## About Journal

**Eksakta : Berkala Ilmiah Bidang MIPA** (<http://issn.lipi.go.id/>) **E-ISSN : 2549-7464** (<http://issn.pdii.lipi.go.id/issn.cgi?daftar&1487060477&1&&>) is an open-access journal and peer-reviewed that publishes either original articles or reviews. This journal is published by the **Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Negeri Padang, Indonesia**. The journal is dedicated to the dissemination of knowledge related to the advancement in scientific research. The prestigious interdisciplinary editorial board reflects the diversity of subjects covered in this journal. Under science and technology, the coverage includes environmental science, pure and applied mathematics, agricultural research and engineering, biology, biotechnology, and bioinformatics. Healthcare sciences (including clinical medicine, preventive medicine, and public health), physics, biophysics, computer science, chemistry, and bioengineering, to name a few. Since 2017 (Volume 19) **Eksakta : Berkala Ilmiah Bidang MIPA (E-ISSN : 2549-7464)** (<http://issn.pdii.lipi.go.id/issn.cgi?daftar&1487060477&1&&>) publishes two issues (numbers) annually (**April** and **October**). On **9 October 2020**, the **frequency of journal publications** changed through the **ISSN LIPI decree**. The ISSN LIPI letter stated that starting in **2021**, our journal will **publish four issues in a year**, namely **January, April, July, and October**. The **first issue (No 1)** is published **every 30 January**, the **second issue (No 2)** is published **every 30 April**, the **third issue (No 3)** is published **every 30 July**, and the **fourth issue (No 4)** will be published **every 30 October**.



(<http://eksakta.pjj.unp.ac.id/index.php/eksakta/issue/view/9>)

### in-progress

DOI: <https://doi.org/10.24036/eksakta/vol22-iss1> (<https://doi.org/10.24036/eksakta/vol22-iss1>)

Published: Oct 11, 2020

## Eksakta : Berkala Ilmiah Bidang MIPA

Optimization of the Optimum Condition of Mushroom Light Excitation (*Neonothopanus* sp) Bioluminescence (<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/232>)

[10.24036/eksakta/vol22-iss1/232](https://doi.org/10.24036/eksakta/vol22-iss1/232) (<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/232>)

1-9

Mila Qurniawati, Ratna wulan

pdf (<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/232/127>)

474

The Effect of Graphite Concentration in TiO<sub>2</sub> Semiconductors on Efficiency of Dye Sensitized Solar Cells (DSSC) Using Dye *Melastoma malabathricum* L Fruit Extract (<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/260>)

[10.24036/eksakta/vol22-iss1/260](https://doi.org/10.24036/eksakta/vol22-iss1/260) (<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/260>)

10-17

Diah Riski Gusti, Diah Mastutik, Intan Lestari, Yuliana Walidatur Rofiah

[eksakta.pjj.unp.ac.id/index.php/eksakta/issue/view/9](http://eksakta.pjj.unp.ac.id/index.php/eksakta/issue/view/9)

1/5

pdf (<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/260/128>)

37

**Potential Hydrophobic Pocket of Squalene Synthase: An In Silico Analysis**  
(<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/256>)

10.24036/eksakta/vol22-iss1/256 (<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/256>)

18-26

**Fitri Amelia, Basultan Hidayat, Iryani Iryani, Iswendi Iswendi**

pdf (<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/256/129>)

28

**Isolation of Cellulolytic Microbes from Bio-Slurry** (<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/263>)

10.24036/eksakta/vol22-iss1/263 (<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/263>)

27-34

**Arief Muammar, Maria Manullang, Mesha Arjuna, Endah Retnaningrum**

pdf (<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/263/131>)

54

**Stem Anatomical Variation of Genus Gyrinops (Thymelaeaceae) in Sulawesi**  
(<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/257>)

10.24036/eksakta/vol22-iss1/257 (<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/257>)

35-45

**Karmilawati Karmilawati, Tri Mulyaningsih, Aida Muspiah, Michiho Ito**

pdf (<http://eksakta.pjj.unp.ac.id/index.php/eksakta/article/view/257/132>)

26



**Make Submission** (</index.php/eksakta/about/submissions>)



**Editorial Team** (</index.php/eksakta/about/editorialTeam>)



**Peer Reviewers** (</index.php/eksakta/reviewer>)



**Peer Review Process** (</index.php/eksakta/prp>)



**Focus and Scope** (</index.php/eksakta/scope>)



**Author Guidelines** (</index.php/eksakta/authorguidelines>)



**Publication Ethics** (</index.php/eksakta/ethics>)



**Online Submission** (</index.php/eksakta/about/submissions>)



**Online Submission Guidelines** (</index.php/eksakta/onlineguidline>)




**Plagiarism Check** (</index.php/eksakta/plagiarism>)




**Article Processing Charge** (</index.php/eksakta/fees>)




**Open Access Statement** (</index.php/eksakta/openaccess>)

 Rights and License (</index.php/eksakta/license>)

 Statistics (<http://statcounter.com/p11849639/?guest=1>)

 Template ([https://drive.google.com/file/d/1jpFGGp4HNxVAbq0-ftAAB4lo-4n2Y\\_04/view?usp=sharing](https://drive.google.com/file/d/1jpFGGp4HNxVAbq0-ftAAB4lo-4n2Y_04/view?usp=sharing))

 Journal History (</index.php/eksakta/History>)

 Contact Office and Map (</index.php/eksakta/contactmaps>)

#### Article Template



([https://drive.google.com/file/d/1jpFGGp4HNxVAbq0-ftAAB4lo-4n2Y\\_04/view?usp=sharing](https://drive.google.com/file/d/1jpFGGp4HNxVAbq0-ftAAB4lo-4n2Y_04/view?usp=sharing))

#### Scopus Citation Tracker



(<https://drive.google.com/file/d/1EUI7liUENIHgW-NSWkCoy9yRR16b2XVn/view?usp=sharing>)

#### e-ISSN dan p-ISSN



(<http://issn.pdii.lipi.go.id/issn.cgi?daftar&1487060477&1&&>)



(<http://issn.pdii.lipi.go.id/issn.cgi?daftar&1180430335&1&&>)

#### Colaborated



(<https://ics-physical-chemistry.org/#:~:text=Divisi%20KF>)

#### Accreditation

Eksakta : Berkala Ilmiah Bidang MIPA is Nationally Accredited in SINTA 4

## Accreditation Number

(Ministry of RTHE): 10/E/KPT/2019

([http://arjuna.ristekdikti.go.id/files/berita/Salinan\\_Kepdirjen\\_Risbang\\_Tentang\\_Peringkat\\_Akreditasi\\_Jurnal\\_Ilmuah\\_Periode\\_II\\_Tahun\\_2019.pdf](http://arjuna.ristekdikti.go.id/files/berita/Salinan_Kepdirjen_Risbang_Tentang_Peringkat_Akreditasi_Jurnal_Ilmuah_Periode_II_Tahun_2019.pdf)) No.12, date April 4, 2019.



(<http://sinta2.ristekdikti.go.id/journals/detail?id=4055>)

## Editorial Team

## Meet Our Editorial Team

## Editor In Chief

**Dr. Rahadian Zainul, M.Si.**Scopus ID : 56737195700 (<https://www.scopus.com/authid/detail.uri?authorId=56737195700>)Orcid : 0000-0002-3740-3597 (<http://orcid.org/0000-0002-3740-3597>)

Universitas Negeri Padang

## Managing Editor

**Ade Cahya, S.Kom**

Scopus ID :-

Orcid : 0000-0002-0141-3267 (<http://orcid.org/0000-0002-0141-3267>)

Universitas Negeri Padang

## Editorial Board

**Viko Ladelta, Ph.D**Scopus ID : 56527279100 (<https://www.scopus.com/authid/detail.uri?authorId=56527279100>)Orcid : 0000-0002-0141-3267 (<http://orcid.org/0000-0002-0141-3267>)

King Abdullah University of Science and Technology, Arab Saudi

**Dr. Yosza Dasril Ph.D**Scopus ID : 6505715619 (<https://www.scopus.com/authid/detail.uri?authorId=6505715619>)Orcid : 0000-0002-3740-3597 (<http://orcid.org/0000-0002-3740-3597>)

Universiti Teknikal Melaka, Malaysia

**Prof. Dr. Dra. R. Iis Arifiantini, MSi.**Scopus ID : 57190674189 (<https://www.scopus.com/authid/detail.uri?authorId=57190674189>)Orcid : 0000-0002-3740-3597 (<http://orcid.org/0000-0002-3740-3597>)

Institut Pertanian Bogor, Indonesia

**Prof. Dr. Ing. Mitra Djamal**Scopus ID : 6506355194 (<https://www.scopus.com/authid/detail.uri?authorId=6506355194>)Orcid : 0000-0002-4698-2949 (<https://orcid.org/0000-0002-4698-2949>)

Institut Teknologi Bandung, Indonesia

**Dr. Dedy H.B. Wicaksono, S.T., M.Eng.**Scopus ID : 57189079217 (<https://www.scopus.com/authid/detail.uri?authorId=57189079217>)Orcid : 0000-0003-1218-6853 (<http://orcid.org/0000-0003-1218-6853>)

Swiss German University, Indonesia

**Dr Hamidreza Kashefi**Scopus ID : 36761108900 (<https://www.scopus.com/authid/detail.uri?authorId=36761108900>)Orcid : 0000-0000-0000-0000 (<http://orcid.org/0000-0000-0000-0000>)

Farhangian University, Iran

## Information

For Readers (<http://eksakta.ppj.unp.ac.id/index.php/eksakta/information/readers>)For Authors (<http://eksakta.ppj.unp.ac.id/index.php/eksakta/information/authors>)For Librarians (<http://eksakta.ppj.unp.ac.id/index.php/eksakta/information/librarians>)

(<http://sinta2.ristekdikti.go.id/journals/detail?https://id=4055>) user=PI



**UNP**  
Universitas Negeri Padang

2  
✉ Address

Jl. Prof Dr Hamka, Kampus Air Tawar  
Padang-Indonesia

## 👤 Contact Info

Telp. +62751-7057420  
Fax. +62751-7057420  
[eksakta@ppj.unp.ac.id](mailto:eksakta@ppj.unp.ac.id)

© 2019 Eksakta : Berkala Ilmiah Bidang MIPA (E-ISSN : 2549-7464) (<http://issn.pdii.lipi.go.id/issn.cgi?daftar&1487060477&1&1&1>), All rights reserved. This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (<https://creativecommons.org/licenses/by/4.0/>) a Creative Commons Attribution 4.0 International License (<https://creativecommons.org/licenses/by/4.0/>).  
Site using OJS 3 PKP optimized (<http://eksakta.ppj.unp.ac.id/index.php/eksakta/about/aboutThisPublishingSystem>)  
This Site Crafted by <http://acahya.web.id> (<http://acahya.web.id>) (<https://www.youtube.com/c/acahyachannel>)

## Article

# Stem Anatomical Variation of Genus *Gyrinops* (*Thymelaeaceae*) in Sulawesi

### 3 Article Info

#### Article history :

Received December 20, 2020  
Revised December 31, 2020  
Accepted December 31, 2020  
Published January 4, 2021

#### Keywords :

Agarwood, *Gyrinops*,  
*interxylary phloem*, plant  
anatomy, Sulawesi

Karmilawati<sup>1\*</sup>, Tri Mulyaningsih<sup>1</sup>, Aida Muspiah<sup>1</sup>, Michiho Ito<sup>1</sup>

<sup>1</sup>Department of Biology, Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Mataram, Indonesia

<sup>2</sup>The Graduate School of Pharmaceutical Sciences, Kyoto University, Japan

**2 Abstract.** The purpose of this study was to determine the variation of the stem anatomical structure (i.e. cortex: sclerenchyma, phloem; xylem: trachea, rays, *interxylary phloem* and wood parenchyma; and pith) of *Gyrinops* (Thymelaeaceae) in Sulawesi. The method of this research was descriptive exploration. Stem agarwood sample came from several regions areas of Sulawesi which were collected by Agarwood Research Center Laboratory, Faculty of Mathematics and Natural Sciences, University of Mataram. The slide methods were used fresh slides. The results of this research showed there were 1 species of *Gyrinops decipiens* and 3 species of *Gyrinops* sp., with various anatomical characters in *G. decipiens* and *Gyrinops* sp. in terms of the position, diameter and percentage of pith thickness; cortical sclerenchyma pattern and arrangement of wood parenchyma. There were also variations in cortical thickness; diameter, frequency and arrangement of trachea; frequency of rays; diameter, and *interxylary phloem* frequency; pith diameter; and the position of Ca-Oxalate in *Gyrinops* sp. 3 with *Gyrinops* sp. 1 and 2, while *Gyrinops* sp. 2 with *Gyrinops* sp. 1 there were found 5 variations such as the diameter, frequency and arrangement of trachea; arrangement of rays and *interxylary phloem* length.

**3** This is an open access article under the [CC-BY](https://creativecommons.org/licenses/by/4.0/) license.



This is an open access article distributed under the Creative Commons 4.0 Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. ©2021 by author.

#### Corresponding Author :

Tri Mulyaningsih  
Department of Biology, Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Mataram, Indonesia  
Email : [trimulya@unram.ac.id](mailto:trimulya@unram.ac.id)

## 1. Introduction

Agarwood with aroma typical used the community in the Middle East as a fragrance material because it has a high aromatic levels of resin and distinctive. In China, Agarwood is utilized as abdominal pain medication, kidney disorders, hepatitis, asthma, cancer, tumors, and stress [1]. Agarwood products of both genera are *Gyrinops* and *Aquilaria* considered endangered, so in the logging and trade should be regulated and restricted [2].

Research on wood stem agarwood can be done based on its anatomic characteristic to help identify the agarwood according to the type of agarwood trees especially those originating from Sulawesi, so it can be used as a key character to classification based on anatomical evidence. Agarwood tree from genus *Gyrinops* Familia Thymelaeaceae is found in Sulawesi, one of which is *G. decipiens* that live at an altitude of 400-800 m, which is scattered in west, central and South Sulawesi [3,4]. *Gyrinops decipiens* is found in Kulawi village, Tuwulu, Ulu Karosa river, Jerman wall and mount Lengke around lake Towuti, Wavatoli, Pararahi in Central Sulawesi, and on mount Luwu Utara in South Sulawesi [3,4].

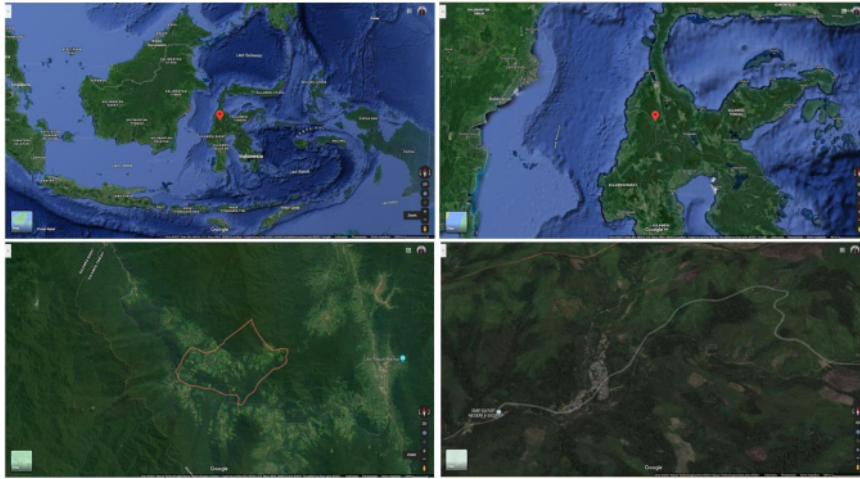


Figure 1. Google Map of Kulawi, Tuwulu, Central Sulawesi.

Research on the anatomy of agarwood tree producing mainly genus *Gyrinops* that have character with the presence of included or interxylary phloem type foraminated which is the cells that are nearby which is the cell sheath and parenchyma is a distinguishing character with other genera. Included phloem (interxylary phloem) forms a fusiform arrangement that surrounds the very prominent sclerenchyma cells. Interxylary phloem in the trunk of a *G. versteegii* trees are scattered in xylem, one of its functions as a distributor of food juices throughout the wooden tissues. Some agarwood trees have different character traits on his anatomy one of them on *Aquilaria* and *Gyrinops*. *Aquilaria malaccensis* has a moderate diameter, 100-200  $\mu\text{m}$ , with a frequency less than 10 per mm, and with a radial double vessel 2-4 cells. *Gyrinops versteegii* has a slightly smaller diameter vessel, averaging less than 100  $\mu\text{m}$ , with frequency is more than 10 per mm and with a radial double vessel 2-6 cells [5]. The purpose of the study is to determine the variation of the anatomical structure of the trunk (cortex parenchyma, periderm, cortex sclerenchyma, trachea, rays, interxylary phloem, and pith) of the genus *Gyrinops* (Thymelaeaceae) in Sulawesi.



## 2. Materials and Methods

This research is descriptive exploration and conducted in the Agarwood Research Center Laboratory, Faculty of Mathematics and Natural Sciences, University of Mataram. Samples of Agarwood tree trunk genus *Gyrinops* used are specimens from Sulawesi, among others: (1) TM-MI 393 Rambu, South Kanowe, Kendari; (2) TM-MI 394 Rambu, South Kanowe, Kendari; (3) TM-MI 402 Petambua, Radda, North Luwu, North Sulawesi; (4) TM-MI 403 Maipi, Lero Sabang, North Luwu; (5) TM-MI 408 Timoro, Tabulahan, Mamasa; (6) TM-MI 405 Salubulung, Tabulahan, Mamasa.

Preparation of a cross section of Agarwood tree organ to use fresh method. The fresh method begins with a slicing the stem cross-section as thin as possible, the stem slicing's were placed on an object glass and stained with phloroglucinol 1% (alcohol 95%) was allowed for 5 minutes, then dropped solution 18% HCl (aq.) was allowed for 5 minutes until the specimen changes color to slightly reddish, then the solution is removed and, than covered with solution 18% HCl (aq.). Xylem, sclerenchyma and sclereid will be stained pink-red [6].

The collected data is analyzed in the description analysis. Characteristics of the observed parameters were the thickness of the cortex, xylem and pith; the shape of the sclerenchyma; diameter of the phloem, trachea, interxylary phloem and pith; the frequency of trachea, rays and interxylary phloem, the arrangement of the trachea, rays and wood parenchyma; interxylary phloem length, interxylary phloem form; the position of pith; the position and form of Ca-oxalate [1,5,7,8,9]. For measuring the shape of a cell character such as the thickness of the cortex, xylem, pith and interxylary phloem; diameter of phloem, trachea, interxylary phloem and pith; As well as long interxylary phloem using the application Image J software. The Data of the analysis results were presented in the form table, description and image.

## 3. Results and Discussion

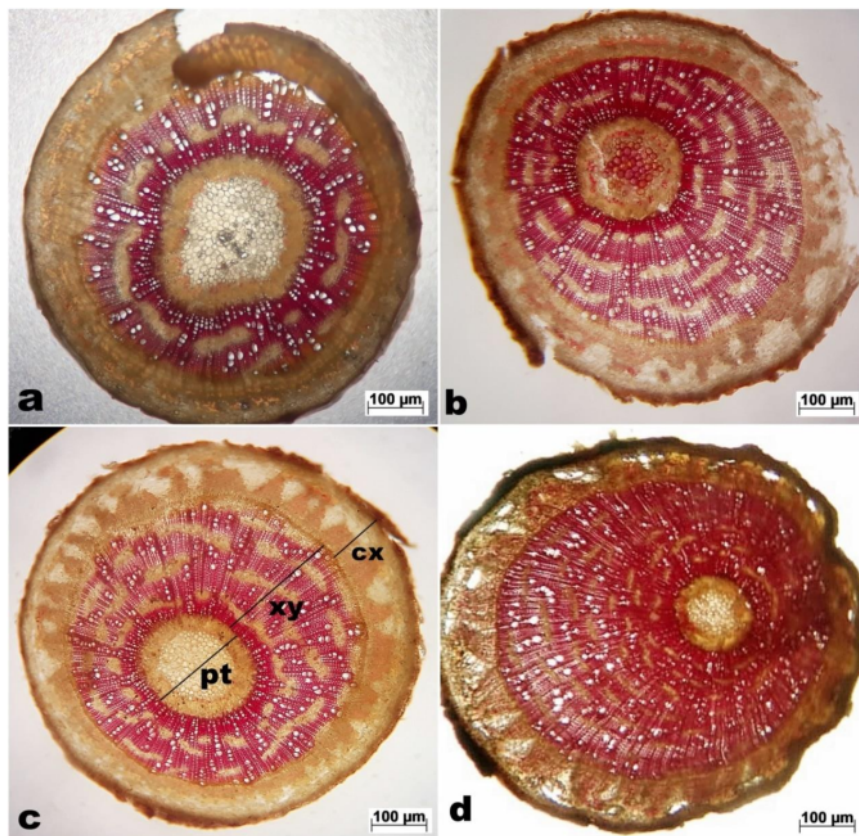
Research results of the stem anatomical genus *Gyrinops* in Sulawesi were showed that the distribution of species genus *Gyrinops* in Sulawesi is as follows; *G. decipiens* is located in Konawe, Kendari Southeast Sulawesi; *Gyrinops* spp. 1a and *Gyrinops* spp. 3 in North Luwu, South Sulawesi; *Gyrinops* spp. 1b Mamasa; *Gyrinops* spp. 2 in Mamasa, West Sulawesi. The anatomical structure of *Gyrinops* (Thymelaeaceae) in Sulawesi were examined, suggesting that the genus *Gyrinops* species were composed of three large tissues consisting pith, cortex and xylem.

### 3.1 Pith

The position of pith in some species of genus *Gyrinops* affects the thickness and diameter of the pith, where the position of the pith of the affected *Gyrinops* species was divided into two namely those located in the central and peripheral parts. The pith position of *G. decipiens* is in the central part and on four species of *Gyrinops* sp. The other was located in the peripheral parts (Fig. 2). The pith network is generally located in the center of the trunk, the position of the pith is influenced by the direction of light, and for the tree *G. versteegii* pith is located in an eccentric [10]. With these different pith positions affects the percentage of thickness and diameter of the pith.

The position of the pith in the central section of *G. decipiens* causes a percentage of the thickness of the pith to be greater than that of the *Gyrinops* sp., in a species that has the largest percentage of pith thickness found in *G. decipiens* 2 for  $56.82\% \pm 2.94$  (table 1). In all three species of *Gyrinops* sp. with the position of pith is in the peripheral have a percentage of the thickness of the pith is smaller than that of *G. decipiens*, which is the lowest thickness of the pith in *Gyrinops* sp. 1 of  $33.59\% \pm 2.86$ . According to Mulyaningsih [10] The pith tissue is not significantly influenced by the

difference in light intensity but is influenced by the direction of light. The position of the pith in the central section of *G. decipiens* affects the diameter of the pith cell. The species *G. decipiens* has a diameter of the pith cell at greater than that of the other four species of *Gyrinops* sp. The largest diameter of the Pith is in *G. decipiens* 1 of  $157.72 \mu\text{m} \pm 13.68$  and the lowest diameter of pith is in *Gyrinops* sp. 1, i.e.  $104.88 \mu\text{m} \pm 15.39$  (table 1).



**Figure 2.** The cross section of the stem of the genus *Gyrinops* in Sulawesi. Note: (a) *G. decipiens*, (b) *Gyrinops* sp. 1, (c) *Gyrinops* sp. 2, (d) *Gyrinops* sp. 3, (cx) cortex, (xy) xylem, (pt) pith

A comparison of the percentage thickness of the cortex, xylem and pith in each species has a variation, with the percentage of the thickness of the largest cortex in *G. decipiens* 1 which is  $29.17\% \pm 2.21$  with thickness ratio in the cortex: xylem: pith (  $29.17\%: 19.48\%: 51.35\%$ ), while for the smallest cortex thickness found in *G. decipiens* species 2 is  $20.24\% \pm 1.37$  with a ratio of cortex: xylem: pith ( $20.24\%: 22.95\%: 56.82\%$ ). For the largest percentage of xylem thickness is in *Gyrinops* sp. 1, which is  $40.8\% \pm 2.02$  with percentage comparison thickness of cortex: xylem: pith ( $25.61\%: 40.8\%: 33.59\%$ ). *Gyrinops* species with the smallest percentage of xylem thickness is found in *G.*

decipiens 1  $19.48\% \pm 1.48$  with a percentage comparison thickness of the cortex: xylem: pith (29.17%: 19.48%: 51.35%) (Table 1).

### 3.2 Cortex

Based on the results of the study showed that from the stem species of the genus *Gyrinops*, the observed cortex tissue has variations on the sclerenchyma and phloem. The results of the study showed that the sclerenchyma forming the trapezoidal buildings are found in *G. decipiens*. Meanwhile, *Gyrinops* sp. 1, 1b, 2, and 3 have cone-shaped sclerenchyma, on the edge cover of the sclerenchyma there is a sclereida. It is similar to the research results Mulyaningsih [10], that in *G. versteegii* has a cone-shaped sclerenchyma pattern, but at the end of the sclerenchyma is not found sclereida.

Variations of the phloem tissue of some species of *Gyrinops* are found, there is a variation on the diameter of the phloem, with the largest phloem diameter of *G. decipiens* of  $67.83 \mu\text{m} \pm 17.28$  and the smallest diameter found in *Gyrinops* sp. 1 with a diameter of  $58.54 \mu\text{m} \pm 9.84$ . The thickness of phloem in *A. malacensis* with treatment on a spacious capacity of 100% have a layer thickness of phloem  $145.80 \mu\text{m} \pm 4.66$ , so the size of the thickness is 2-3 times wider than the thickness In the genus *Gyrinops* [11].

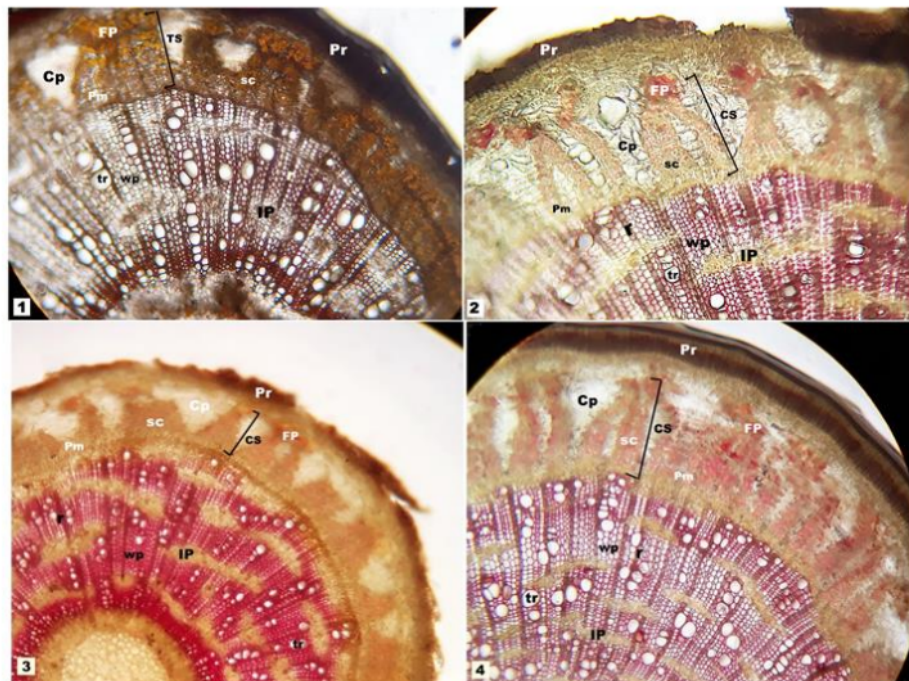
### 3.3 Xylem

Based on the results of the research on the xylem network, indicating the variation in diameter, frequency and arrangement of trachea; arrangement and frequency of rays; thickness, length, frequency and form of interxylary phloem; and arrangement of wood parenchyma. The largest trachea diameter in *G. decipiens* 2 is  $211.18 \mu\text{m} \pm 36.95$  and the smallest in *Gyrinops* sp. 2 is  $141.64 \mu\text{m} \pm 19.80$  ( table 1). The measurement results of this diameter, has a range similar to the research results Mandang & Wiyono [5] trachea diameter for *A. malacensis* up to  $190 \mu\text{m}$  with an average of  $141 \pm 37 \mu\text{m}$  and tracheal diameter at *G. versteegii* up to  $131 \mu\text{m}$  with an average of  $89 \pm 5 \mu\text{m}$ . Similarly to the research results Andianto [7], the diameter of the trachea has the same range that is for *G. cumingiana*  $116-144 \mu\text{m}$ .

This difference was suspected because of the sampling of wooden rods at the age and location of the different position on the tree as well as the location of the growing place [7]. Based on Wheeler [9], trachea wood diameter is included in the group of  $50 - 100 \mu\text{m}$ . Xylem tissues arrangement that has thicker cell walls produces a fragrant resin in the cells that form aromatic resin liquid then gathered and compacted on one side of the wall in the cell, more brown in color known as the Agarwood. The thicker the line that is formed increasingly heavier and thicker is produced [12]. Based on the results of the research *Gyrinops* found in Sulawesi has a small trachea cells so it belongs to the wood of a solid half, and different from the *Gyrinops* that exist in the NTB by having a large and more porous tracheal cells.

The highest tracheal per mm<sup>2</sup> frequency is the *Gyrinops* sp. 3 of  $39.7 \pm 8.33$  and the lowest in *G. decipiens* 2 with a frequency of  $16.7 \pm 3.56$ . According to Metcalfe and Chalk [13], species of Thymelaeaceae has a frequency characteristic of vessels ranging from 4-15 per mm<sup>2</sup>. The genus *Gyrinops* which is a member of the Thymelaeaceae, has a frequency of 5-20 pores per mm<sup>2</sup> square [9], and in Andianto's reasearch [7] of tracheal frequency at *G. cumingiana* as much as 14 pores per mm<sup>2</sup> and at *G. versteegii* as much as 19 per mm<sup>2</sup>, while the Mandang & Wiyono [5] has an 18 tracheal frequency per mm<sup>2</sup>. *G. versteegii* had an average tracheal frequency of 14 per mm<sup>2</sup>, a maximum of 37 pores per mm<sup>2</sup>, the results obtained in the study were almost identical to that range, especially in *G. decipiens*, but in *Gyrinops* sp. 3 exceeded the trachea frequency range [14].

The observation of the stem tracheal arrangement of the genus *Gyrinops* in Sulawesi (Table 1), has a varied arrangement of solitary, cluster and series. Variations found in the tracheal arrangement are lined up, with the highest-lined tracheal arrangement with a total of 2-7 cells/seriates in *G. decipiens* and *Gyrinops* sp. 2 and the lowest in *Gyrinops* sp. 3 with a total of 2-3 cells/seriat. In Mulyaningsih's & Sumarjan research [15], the trachea cells of *G. versteegii* form a series, a cluster or a solitary (singular). In a series usually composed 2-4 trachea cells are rarely composed of 5 cells, the same as in the form of clusters. According to Mandang and Wiyono [5], the type *A. malacensis* shows 2-3 (-4) cells while in the research results of Andianto [7] *A. malacensis* has a tracheal arrangement of 2 (-3-4) cells and in *Gyrinops* 2-3-4 (-8) cells. These differences are allegedly related with the process of cell growth in trees [14].



**Figure 3.** The Cross section of the stem and *Gyrinops* genus sclerenchyma shape pattern in Sulawesi. Note: (1) *G. decipiens* 1, (2) *Gyrinops* sp.1, (3) *Gyrinops* sp. 2, (4) *Gyrinops* sp. 3, (Ts) trapezoidal- shaped sclerenchyma pattern, (CS) cone-shaped sclerenchyma pattern, (Pr) periderm, (cp) cortex parenchyma, (Pm) phloem, (sc) sclerenchyma, (tr) trachea, (wp) wood parenchyma, (r) rays, (IP) interxylary phloem, (FP) fiber pericycle

The rays of the study was found in several contexts, including the uniseriat, biseriat and triseriat. In *G. versteegii* radius arrangement is generally one series and rarely 2 series [14], on the anatomy research of agarwood earlier rays on *Gyrinops* usually have uniseriat arrangement [7,9,15,16,17,18]. Meanwhile, according to Mandang & Wiyono [5], *G. versteegii* has a rays 2 series, in the results of this study, not only obtained the arrangement of the rays 1 or 2 series but in some species that have been examined in the rays to 3 Series. The cells form the rays against the rod axis and in the cells

contain the stem-shaped Ca-oxalate crystals and the inclusion of globular (granules) [10]. However, in this study, Ca-oxalate crystals were found in the cortex parenchyma, phloem, Interxylary phloem and pith, not found Ca-oxalate crystals on the rays (Table 2).

The frequency at the rays per mm<sup>2</sup> with the highest frequency on the *Gyrinops* sp. 3 with a frequency of  $10.2 \pm 1.62$  and the lowest in *Gyrinops* sp. 1 with a frequency of  $7.2 \pm 1.69$ . According to Asdar [14], *G. versteegii* have an average frequency of  $8.4 \pm 3$  per mm<sup>2</sup>, while in the research Andianto (2010) *G. versteegii* has a frequency of 5 per mm<sup>2</sup> and in *Gyrinops*, it has a frequency of 7 per mm<sup>2</sup>.

Interxylary phloem thickness of the species of the genus *Gyrinops* is the highest in the *Gyrinops* sp. 1 with  $291.08 \mu\text{m} \pm 69.44$  and the lowest with a thickness of  $127.93 \mu\text{m} \pm 50.32$  on *G. decipiens* 2, the result is almost identical to the results of the research [19,20], the thickness of interxylary phloem on *Aquilaria sinensis* with a radial attachment having a thickness of interxylary phloem  $139 \mu\text{m} \pm 21\mu\text{m}$ , whereas the thickness of the interxylary phloem on a species that is not a producer of agarwood such as *Strychnos bredemeyeri* has a thinner thickness of  $32-37 \mu\text{m}$  ( $35 \mu\text{m} \pm 1.82$ ) [21]. Interxylary phloem thickness is influential in the formation of agarwood in nature, because interxylary phloem one of its functions as a transports food to the entire tissue of wood, so the formation of agarwood starts from the inside, Interxylary phloem then radiating to the rays, then filling the trachea (xylem), and then filling the other parts of the cells [15]. The existence of Interxylary phloem, causing agarwood trees will be very responsive to the need in the body by forming a new tissue to cover the wound.

The largest length of interxylary phloem with a measurement result of  $2553.34 \pm 525.85$  on *Gyrinops* sp. 2 and the smallest in *G. decipiens* 2 with a length of  $354.97 \mu\text{m} \pm 78.77$  (Table 1), for long interxylary phloem on *Strychnos bredemeyeri* of  $426 \mu\text{m}-514 \mu\text{m}$  ( $468 \mu\text{m} \pm 9.69$ ) [21]. The highest phloem interxylary frequency on *Gyrinops* sp. 3 has a frequency of 61 per circle rod and the lowest at *G. decipiens* 1 with a frequency of 13 per circular rod. Formation of on the tissue of aloe wood is done by an organelles contained in the tissue interxylary phloem and radius called Globula [22]

The Interxylary phloem form of the species *G. decipiens* and *Gyrinops* sp. has forms including oblongate, lanset, elliptical and linear, some species have the same interxylary phloem form on *G. decipiens* 1 and 2, on *Gyrinops* sp. 1 and 2 equally have oblong, linear and elliptical shapes, as well as different shapes on *Gyrinops* sp. 1 with oblong shape, lancet and while on *Gyrinops* sp.3 has interxylary phloem with oblong shape, linear and lancet (table 1, figure 2). In the natural, agarwood is found in interxylary phloem among of them in *A. Agallocha*. [13,17,23,24]. According to Mulyaningsih, et al., [10] and Lou et al., [20], interxylary phloem is scattered in the network of xylem forming the units of the islands. One island is composed of a bunch of reed cells and parenchyma phloem that surround a set of silk fibers (sclerenchyma cells). Inside the parenchymed cells phloem and sieve tube contain the crystals of the Ca-oxalate stem and inclusion form globular. The number of islands Interxylary phloem depends on the thick layer of the xylem coating. The thicker the xylem layer then the number of rows of interxylary phloem Islands will be more and more.

The arrangement of wood parenchyma from the results showed that at *G. decipiens* has the lowest wood parenchyma arrangement of 1-5 lines and the most wooden parenchyma arrangement with the order of 1-9 lines i.e. in *Gyrinops* sp. 1. Some species of genus *Gyrinops* are *Gyrinops* sp. 2 and 3 with an order of 1-6 lines, then on *Gyrinops* sp. 1 have a wooden parenchyma arrangement as much as 1-7 lines. Parenchyma tissue and tracheid parallel series with the rays cells [10]. The area of infected wood tissues influence the formation of agarwood formed on bark. The wider the wood

tissue is infected the larger the volume of the captured timber tissue, indicating the extension of the formation of spot-spot mastic on a wood tissue that has been inoculated [25].

**Table 1.** Stem anatomical features *Gyrinops* spp. (Thymelaeaceae) in Sulawesi

No	Characteristic of Tissue	<i>G. decipiens</i>	<i>Gyrinops</i> sp. 1	<i>Gyrinops</i> sp. 2	<i>Gyrinops</i> sp. 3
1	Pith position	Central	Perifer	Perifer	Perifer
2	Pith diameter ( $\mu\text{m}$ )	155,11 $\pm$ 10,87	163,46 $\pm$ 16,37	112,08 $\pm$ 13,06	133,58 $\pm$ 29,22
3	Cortex thickness (%)	39,29 $\pm$ 1,79	27,17 $\pm$ 0,86	27,06 $\pm$ 2,41	21,4 $\pm$ 0,88
4	Xylem thickness (%)	21,21 $\pm$ 1,8	34,04 $\pm$ 2,8	38,87 $\pm$ 1,53	34,68 $\pm$ 1,75
5	Pith thickness (%)	54,08 $\pm$ 1,88	38,77 $\pm$ 3,42	34,06 $\pm$ 1,71	43,92 $\pm$ 1,04
6	Sclerenchyma cortex pattern	Form a rectangular building	Form a conical building	Form a conical building	Form a conical building
7	Phloem Diameter ( $\mu\text{m}$ )	64,13 $\pm$ 15,86	60,75 $\pm$ 7,21	67,32 $\pm$ 2,37	67,28 $\pm$ 10,59
8	Tracheal Diameter ( $\mu\text{m}$ )	177,665 $\pm$ 43,51	157,45 $\pm$ 18,71	141,64 $\pm$ 19,80	206,26 $\pm$ 29,37
9	Tracheal frequency (per $\text{mm}^2$ )	17,15 $\pm$ 3,43	19,35 $\pm$ 4,06	22,3 $\pm$ 4,16	39,7 $\pm$ 8,33
10	Arrangement of trachea	Series (2-7 sel/seriat), cluster dan solitary	Series (2-6 sel/seriat), cluster dan solitary	Series (2-7 sel/seriat), cluster dan solitary	Series (2-3 sel/seriat), cluster dan solitary
11	Arrangement of rays	Uniseriat & biseriat	Uniseriat, biseriat & triseriat	Uniseriat	Uniseriat & biseriat
12	Rays frequency (per $\text{mm}^2$ )	9,05 $\pm$ 2,51	8,2 $\pm$ 1,58	9,4 $\pm$ 1,51	10,2 $\pm$ 1,62
13	Interxylary phloem diameter ( $\mu\text{m}$ )	195,12 $\pm$ 30,8	285,28 $\pm$ 54,71	274,89 $\pm$ 23,06	164,15 $\pm$ 63,81
14	Interxylary phloem length ( $\mu\text{m}$ )	711,74 $\pm$ 186,47	1084,1 $\pm$ 115,17	2553,34 $\pm$ 525,85	850,74 $\pm$ 328,41
15	Interxylary phloem frequency (per batang lingkaran)	17	39	34	61
16	Interxylary phloem form	Oblong, linier & elips	Oblong, linier & elips	Oblong, linier & elips	Oblong, linier & lanset
17	Arrangement of wood parenchyma.	1-5 row	1-9 row	1-6 row	1-6 row

### 3.4 Crystal Ca-oxalate

The Ca-oxalate position of the genus species *gyrinops* that has been researched lies in the cortex parenchyma, the cortex phloem, interxylary phloem and pith with various shapes among which are the shape of the rod-shaped (styloid), druses, elongate and prism. Ca-oxalate in *G. decipiens* is found in the cortex parenchyma and the cortex phloem with the form of rods (styloid) and elongate and in the pith there is a Ca-oxalate form of rod-shape (styloid), elongate and druses. *Gyrinops* sp. 1 found Ca-oxalate with a rod-shape (styloid), elongates and prisms located in the cortex parenchyma and elongate shape, prism and druses on the cortex phloem, whereas on the pith found Ca-Oxalate with the form of a rod shape (styloid), elongate, prism and druses. Ca-oxalate on *Gyrinops* sp. 2 found the rod-shaped (styloid), prism, elongate and druses located in the cortex parenchyma, and on the pith found the form of druses and prism, whereas on *Gyrinops* sp. 3 found the stem shape (styloid) in the cortex parenchyma, druses and elongate forms in the cortex phloem, on interxylary phloem found elongate form and on the pith found a form of prism. In research of Mandang & Wiyono [5] shows that in some species stem agarwood such as *A. malaccensis* and *G. versteegii* Producem mineral inclusion Ca-Oxalate crystal-shaped prism, on *A. malaccensis* Ca-Oxalate crystal-shaped prisms found on the rays and on the *G. versteegii* found in the wooden parenchyma (paratrakea and

apotrakea), whereas for *G. versteegii* found Ca-oxalate in the cortex part of the cortex parenchyma and sieve tube and in the pith parenchyma section with the rod-shaped Ca-Oxalate [10].

**Table 2.** Ca-oxalate form on the stem tissue of *Gyrinops* spp. (Thymelaeaceae) in Sulawesi

No	Characteristic	Parameter feature Ca-Oxalate			
		<i>G. decipiens</i>	<i>Gyrinops</i> sp. 1	<i>Gyrinops</i> sp. 2	<i>Gyrinops</i> sp. 3
1	Position	Cortical parenchyma, cortical p phloem, and pith parenchyma	Cortical parenchyma, cortical p phloem, and pith parenchyma	Cortical parenchyma and pith parenchyma	Cortical parenchyma, cortical phloem, interxylary phloem and pith parenchyma
2	Form	Styloid, elongate, druses	Styloid, elongate, druses, prism	styloid, elongate, druses, prism	styloid, elongate, druses, prism

## 2 Conclusion

Based on the results of this research, it can be concluded that there are of this exploration Sulawesi found 1 species of *G. decipiens* and 3 species of *Gyrinops* sp., There are variation of anatomical characters in *G. decipiens* and *Gyrinops* sp. In the position, diameter and percentage thickness of the pith; sclerenchyma shape, and wood parenchyma arrangement. *Gyrinops* sp. 3 with *Gyrinops* sp. 1 and 2 there are variations in cortical thickness; diameter, frequency and arrangement of the trachea; frequency rays; the diameter and interxylary phloem frequency; diameter of pith; and the Ca-Oxalate position, while *Gyrinops* sp. 2 with *Gyrinops* sp. 1 there are variations in the diameter, frequency and arrangement of the trachea; arrangement of rays and interxylary phloem length.

## Acknowledgements

The authors wish to thank to Graduate School of Pharmaceutical Sciences this part of the research for supporting exploration funding. Faculty of Mathematics and Natural Sciences, University of Mataram for contribution the facilities and equipments for this research. Technician and student Department of Biology, Faculty of Mathematics and Natural Sciences, University of Mataram for helping this research.

## References

- [1] Mulyaningsih T, Marsono D, Sumardi & Yamada I. Selection of Superior Breeding intraspecies Gaharu *Gyrinops versteegii* (Gilg.) Domke. Journal of Agricultural Science and Technology. 2014;4(2):485-492.
- [2] Susmianto A & Santoso E. When Agarwood Becomes Booming. In: Susmianto A, Turjaman M. & Setio P. (Eds). Track Record: Agarwood Inoculation. ed 2. Forestry Research And Development Agency FORDA Press. Bogor. 2014.
- [3] Hou D. Thymelaeaceae. In: Van Steenis C.G.G.J. (ed.) Flora Malesiana. 1960;6 (1):1-160.
- [4] Mulyaningsih T. & Yamada I. Notes on Some Species of Agarwood in Nusa Tenggara, Celebes and West Papua. Faculty of Agriculture, Mataram University -Professor Emeritus, Kyoto University. 2007a.

- [5] Mandang, Y.I & B. Wiyono. Anatomy of Eagle Wood (*Aquilaria malaccensis* Lamk.) and Several Related Species. Forest Products Research Buletin. Forestry Engineering and Forest Products ProCessing Research and Development Center, Forestry Research and Development Agency. Bogor. 2002.
- [6] Donaldson LA. Analysis of fibres using microscopy. In Handbook of Textile Fibre Structure: Fundamentals and Manufactured Polymer Fibres. CRC Press, Boca Raton. 2009: 121-140
- [7] Andianto. Anatomical Features of Five Species Producing-Eaglewood And Two Related Species. Journal of Forest Products Research. 2010;28(2):169-183.
- [8] Angyalossy V, Pace MR & Baas P (eds.). IAWA List Microscopic Bark Features. IAWA Journal. 2016;4(4): 517-615.
- [9] Wheeler EA, Baas P & Gasson PE (eds.). List of Microscopic Features For Hardwood Identification with an Appendix on non-anatomical information. IAWA Bulletin. 1989;10(3): 9-882.
- [10] Mulyaningsih, T., Sumarjan & Parman. Influent of light intensity to anatomy of agarwood made, yearly ring and new tissues on around inoculation holes at eaglewood tree *Gyrinops versteegii* (Gilg) Domke. National Development Planning Agency. 2007;1 (112/113)
- [11] Suharti, Mukarlina & Gusmalawati D. The anatomical structure of the root, stem and leaf of the agarwood (*A. Malaccensis*) that experiences drought stress. Protobiont. 2017;6(2):38-44.
- [12] Mulyaningsih T, Hadi S & Sumarjan. Influence of fungi isolates on the quality of production and bioactive content of agarwood on the ketimunan trees (*G. versteegii* (Gilg.) Domke). In: Paper of National Seminar of Fundamental Research Result, Department Higher Education Directorate of National Education. Jakarta. 2004.
- [13] Metcalfe MM, and Chalk MML. Anatomy of the Dicotyledons, Vol. 2, the Clarendon Press, Oxford, 1923:30-186.
- [14] Asdar. 2006. The Anatomical Characteristics of Eagle Wood (*Gyrinops versteegii* (Gilg.) Domke) from Gorontalo. Perennial Journal. 3(1): 6-10.
- [15] Mulyaningsih T & Sumarjan. Formation Interxylary Phloem and Aromatic Resin In *Gyrinops versteegii* (Thymelaeaceae). IAWA Journal. 2002;23(24): 472-473.
- [16] Mohamed R (ed.). Agarwood Science Behind the Fragrance. Springer Nature. Singapore. 2016. DOI 10.1007/978-981-10-0833-7.
- [17] Rao KR & Dayal R. The Secondary Xylem of *Aquilaria agallocha* (Thymelaeaceae) And The Formation Of 'Agar'. IAWA Bulletin. 1992;13 (2):163-172.
- [18] Widoyanti, Prasetyorini & Ismanto. Differences in Anatomical Structure of Agarwood-Producing Plants from *Aquilaria* spp. and *Gyrinops versteegii*. *Ekologia*. 2017;17(1):1-6.
- [19] Luo B, Ou Y, Pan B, Qiu J, & Itoh T. The structure and development of interxylary and external phloem in *Aquilaria sinensis*. DOI 10.1163/22941932-20170182. Published by Koninklijke Brill NV, Leiden. IAWA Journal. 2018;39 (1):3-17.
- [20] Luo B, Imai T, Sugiyama J, Marsoem SN, Mulyaningsih T and Itoh T. The occurrence and structure of radial sieve tubes in the secondary xylem of *Aquilaria* and *Gyrinops*. IAWA Journal, 2020;41(2):109-124.
- [21] Moya R, Gondaliya AD & Rajput KS. Stem Anatomy And Development of Interxylary Phloem In *Strychnos bredemeyeri* (Loganiaceae). *Anales de Biología*. 2017;39:75-87.
- [22] Mulyaningsih, T., Parman, E.A. Widjaja & Sumarjan. Fungus *Fusarium lateritium* trigger formation agarwood proCess on Ketimunan trees (*Gyrinops versteegii* (Gilg) Domke), in: Scientefic Yearly Meeting. Bandung. 2003.
- [23] Chalk L & Chattaway MM. Identification of wood with included phloem. Tropical wood. 1937;50:1-31.



- 
- [24] Pearson RS, & Brown HP. Commercial timbers of India. Vol. II. Government of India Central Publication Branch. *Calcuta*. 1932:858-864.
- [25] Mulyaningsih T, Parman & Sumarjan. Increasing of bio-processing agarwood with synergisms of some fungi isolate on *Gyrinops versteegii* (Gilg) Domke, in: Article National Seminar of Fundamental Research Result. Department Higher Education Directorate of National Education. Jakarta. 2005.

# B1(17)

---

## ORIGINALITY REPORT

---

**17%**  
SIMILARITY INDEX

**17%**  
INTERNET SOURCES

**3%**  
PUBLICATIONS

**5%**  
STUDENT PAPERS

---

## PRIMARY SOURCES

---

**1** [isaapp2019.unram.ac.id](http://isaapp2019.unram.ac.id) **8%**  
Internet Source

---

**2** [garuda.kemdikbud.go.id](http://garuda.kemdikbud.go.id) **6%**  
Internet Source

---

**3** [1library.net](http://1library.net) **3%**  
Internet Source

---

Exclude quotes      On  
Exclude bibliography      Off

Exclude matches      < 3%

# B1(17)

---

GRADEMARK REPORT

---

FINAL GRADE

**/0**

GENERAL COMMENTS

**Instructor**

---

PAGE 1

---

PAGE 2

---

PAGE 3

---

PAGE 4

---

PAGE 5

---

PAGE 6

---

PAGE 7

---

PAGE 8

---

PAGE 9

---

PAGE 10

---

PAGE 11

---

PAGE 12

---

PAGE 13

---

PAGE 14

---

PAGE 15

---

PAGE 16

---