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Growth Ring and Wood Anatomy Comparison of West Sumatran Ever Green and Conifere Trees

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ABSTRACT: Research on the wood anatomy and growth rings of conifer leaf trees has been carried out from April to December 2022 in the Laboratory of Plant Structure and Development, Department of Biology, Faculty of Mathematics and Natural Sciences, Andalas University. For anatomical wood structure samples, an increment bore was made on the main stem with a height of 130 cm, and tree trunks cut as deep as 55 cm were used. To see whether or not there is a growth ring, booth-checking is carried out macroscopically and microscopically. Macroscopic examination is carried out by sanding tree cores in the transverse section. The results showed that Pinusmerkusii was the only tree species with a growth ring, while Araucaria angustifolia and Casuarinaequisetifolia did not have any growth rings. The three species of coniferous leaf trees only have procumbent cells. Casuarinaeequisetifolia and Pinusmerkusii have uniseriate ray types, while Araucaria angustifoliahas a multiseriate ray type. Araucaria angustifolia and Casuarinaeequisetifolia have a short fiber category, and Pinusmerkusii has a medium category of fiber length.

Key words: anatomy**,** conifer, fiber, growth ring, ray, wood.

I. INTRODUCTION

The tropical climate causes the occurrence of diversity. Trees produce certain patterns in the middle of the tree trunk during the growth and development process, which are commonly referred to as "the growth ring." Growth circumference and weather changes have known correlations and regressions. Weather changes themselves have influencing factors, including temperature changes (Oliveira, 2010).

Growth circumference is a component of trees that serves to record climate change so that it can be used as a source of paleoclimatic information that can be used to reconstruct the climate that can be recorded by lake sediments, ice sheets, growth circumference/circumference of tree years, and others because it allows the use of species in dendrochronological research and its application in climatological studies (Le Truetet al., 2007). Each tree has a certain pattern that is formed annually; this pattern is used to analyze the relationship of climate change over time and estimate how climate change will occur in the future.

Very few dendrochronological studies have been carried out in tropical climates, while in subtropical climates they have been carried out since the beginning of the 20th century (Worbes, 2002). The study of tree species that have a growing circumference in Indonesia is very limited to broadleaf plants. Only six of the forty-six tree species have a clearly defined growth circumference with very different proportions of early wood and late wood cells, according to anatomical observations: Alangiumridleyi, Anisopteracostata, Eugenia cymosa, Nepheliumcuspidatum, and Santiria sp. (Ema, 2015).

Worbes (1999) has researched the effect of the circumference of the year on the growth of tropical trees in Venezuela. The study showed that needle-leaved plants have a significant correlation between the index of the width of the circumference of growth and rainfall. In addition, Yulizah (2014) also conducted a preliminary study on the analysis of growth circumference in P.merkusii, Meliaazedarach, Toonasureni, and Switeniamahagoni in Solok City, West Sumatra. In the study, it was found that there is a clear growth circle in the pine and a number of circles that are almost equal to its estimated age. Based on the explanation above, the study of the growth circumference of coniferous trees as an indicator of global climate change in West Sumatra

II. RESEARCH METHODS

The present study was conducted from April to December 2022. Sample collection was carried out in 3 districts/cities as follows: Araucaria

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heterophylla in TanjungPati, Payakumbuh City and; Casuarinaequisetifolia in Naras, Pariaman City and andPinusmerkusii in X Koto Singkarak, Solok district. Furthermore, the observation and analysis of the circumference of growth were carried out in the Laboratory of Plant Development Structure, Department of Biology, Faculty of Mathematics and Natural Sciences, Andalas University, Padang.

The research method used is a survey method on tree species that are able to form the circumference of growth. Wood sampling (core) is carried out using an increment borer on the trunk at a height of 130 cm from the soil surface. Potential tree species are then followed by anatomical observations of wood with maceration and section method preparation (Sass, 1958). Rainfall data for the study site was obtained from the Sicincin climatology station in West Sumatra.

III. RESULTS AND DISCUSSION

Based on the samples of wood cores that have been analyzed, it is known that of the three types of wood species, only Pinusmerkusii has a growth ring, while Araucaria heterophylla and Casuarinaequisetifolia do not have a growth ring. In Figure 1, it appears that Pinusmerkusii has a clear growth ring, namely, on the surface of the wood core, there are more intensely colored wood zones due to the thickening of the cell wall compared to other zones that appear bright. The zones of more concentrated wood (latewood) are the growth rings formed as a result of seasonal changes during wood growth. Table 1 shows the results of a comparison of the characteristics and anatomical structures of wood from different tree species in transverse, radial, and tangential sections.

Transverse Section

The result is a transverse section (Figure 2). Araucaria heterophylla found tracheids with a tracheid cell diameter of 37.50 µm, Casuarinaequisetifolia found the presence of vessels with a diameter of 80.34 µm and Pinusmerkusii found tracheids with a tracheid cell diameter of 37.50 µm. According to Haygreen and Bowyer (1989), softwood is mostly composed of tracheids, while hardwood is found in the presence of vessels.

Radial Section

On the radial incision (Figure 2), a ray is visible whose height varies between the wood species observed. in Araucaria heterophylla with a ray height of 323.82 µm, Casuarinaequisetifolia at 895.92 µm, and Pinusmerkusii at 246.8 µm. According to Sucipto (2009), Araucaria heterophylla and Pinusmerkusii have extraordinary short rays, while Casuarinaequisetifolia rays are included in the short category.

Quantitative data on the width of the radius of the pith Araucaria heterophylla has a width of 77.19 µm of ray, Casuarinaequisetifolia has a width of 10253 µm of ray, and Pinusmerkusii has a width of 76.10 µm of ray. According to Sucipto (2009), Araucaria heterophylla and Pinusmerkusii have a rather wide category of rays, while the width of the Casuarinaequisetifolia ray is included in the wide category.

Tangential Section

In the tangential section, the structure of the rays and fibers of the wood are observed. Araucaria heterophylla has a type of arrangement of multiseriate rays, while Casuarinaequisetifolia and Pinusmerkusii have a type of arrangement of uniseriate rays (Figure 2). In general, the tangential section shows the type of uniseriate or multiseriate rays. Uniseriate rays have one arrangement of rays from the extent of those rays, while multiseriated rays have more than one arrangement of rays from the extent of those rays.

Figure 1. Wood cores (A) Pinusmerkusii; (B) Casuarina angustifolia; (C) Araucaria heterophylla. Lt. Latewood (growth ring)

Early-wood and Late-wood growth patterns

Based on observations of all wood species, only Pinusmerkusii has a clear early-wood and late-wood boundary (growth ring). The area of early-wood and latewood is influenced by several

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factors, including the location where the tree grows, age, and various other things related to environmental factors such as temperature, rainfall, and sunlight. Then the chronology of the formation of the average growth circle is a combination of climate and environmental factors (Garcia-Suarez et al., 2009).

Based on (Figure 3), Pinusmerkusii, Pine Tree has a clearly distinguishable growth circumference for early-wood and latewood. The size of the width of the earlywood and latewood is not the same for each period of growth of the cambium at the time of forming the growing circle. Merkusii pine wood, during the growth of tracheid late-wood, becomes flattened on tangential cell walls. Another anatomical characteristic is that the diameter of the tracheid cells in the middle of the earlywood is larger, and then the diameter decreases centripetally. This is in accordance with Maideliza (2015), this growth pattern is a growth that is often found in tracheid cells.

Tracheid cells grow in a variety of sizes. At the beginning of the growth of tracheid cells, experience continuous growth called "early-wood," and then experience a slowdown in the growth of tracheid cells or no growth at all called "late-wood" (growth ring). The formation of earlywood and latewood causes the formation of certain patterns called growth rings. According to Kramer (1964) and Zahner (1968), during the rainy season, cambium activity increases, causing tracheid cell diameter to increase. In the dry season, there is a lack of water, which causes a decrease in the rate of enlargement and cell formation. The availability of water affects the number, size, and thickness of cell walls in wood tissue.

In determining the relationship of growth circumference with climate, the data used is rainfall data. Rainfall data is commonly used in dendrochronological studies, although there are many other climatic variables such as temperature, solar index, and others. The climate data used is rainfall data where samples were collected.

In the analysis of the growth of the growing circle and its relationship to the climate, rainfall data from the Unit of Meteorology, Climatology, and Geophysics (hereafter BMKG) at Sicincin station were used. The rainfall data used is Solok District Rainfall Data from 2009–2018 due to limited data

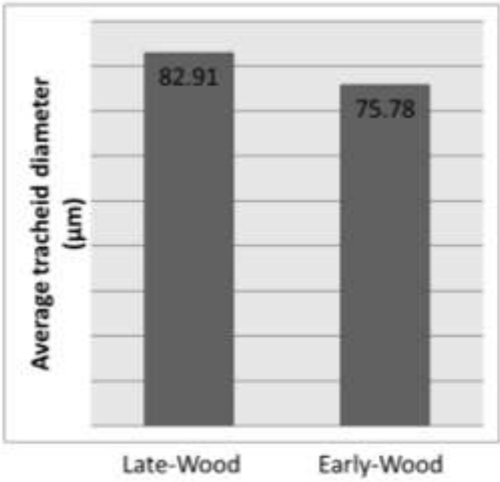

Figure 3. Graph of early-wood and late-wood tracheid diameters of a Pinusmerkusii tree inAripanSolok (401 m above sea level

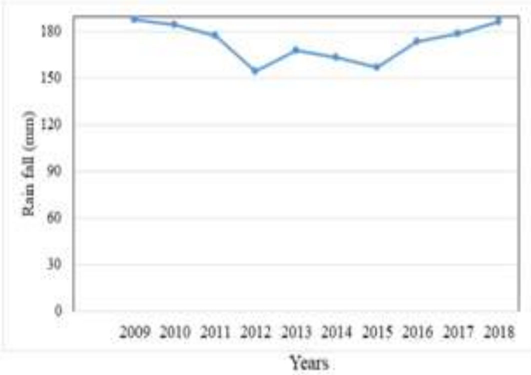

Figure 4. Data on the amount of rainfall in Solokdistrict in 2009 – 2018

In Figure 4, we see a decrease in rainfall followed by a narrowing that occurs in the circumference of the wood growth, which is characterized by thickening of the diameter of tracheid cells, but there is an increase in rainfall that causes the growth of a wider growth circle than the previous year. In certain years, there is a different growth pattern between the circumference and rainfall. Too much rainfall can limit tree growth. This is due to the reduced intensity and duration of solar irradiation required by trees in the process of photosynthesis.

Table 1. Comparison of anatomical structure characters of wood 3 (three) species of coniferous trees

No.	Characters	Species		
		A. heteropylla	C. equisetifolia	P. merkusii
1	Wood Ring	absent	absent	present
2	Diameter of tracheid (µm)	37. 50 ± 4.99	80.34 ± 6.49	76.90 ± 9.67
3	Type of Ray	Uniseriate	Multiseriate	Uniseriate
4	Height of ray (µm)	323.82 ± 124.10	895.92 ± 7.04	246.38 ± 7.28
5	Width of ray (µm)	77.19 ± 2.25	102.53 ±23.05	76.10 ± 9.51
6	Fiber morphology fiber length (µm)	743.56 ± 101.96	727.30 ± 110.54	1276.68 ± 90.28
7	Categoriesfiber length	Short	Short	Medium

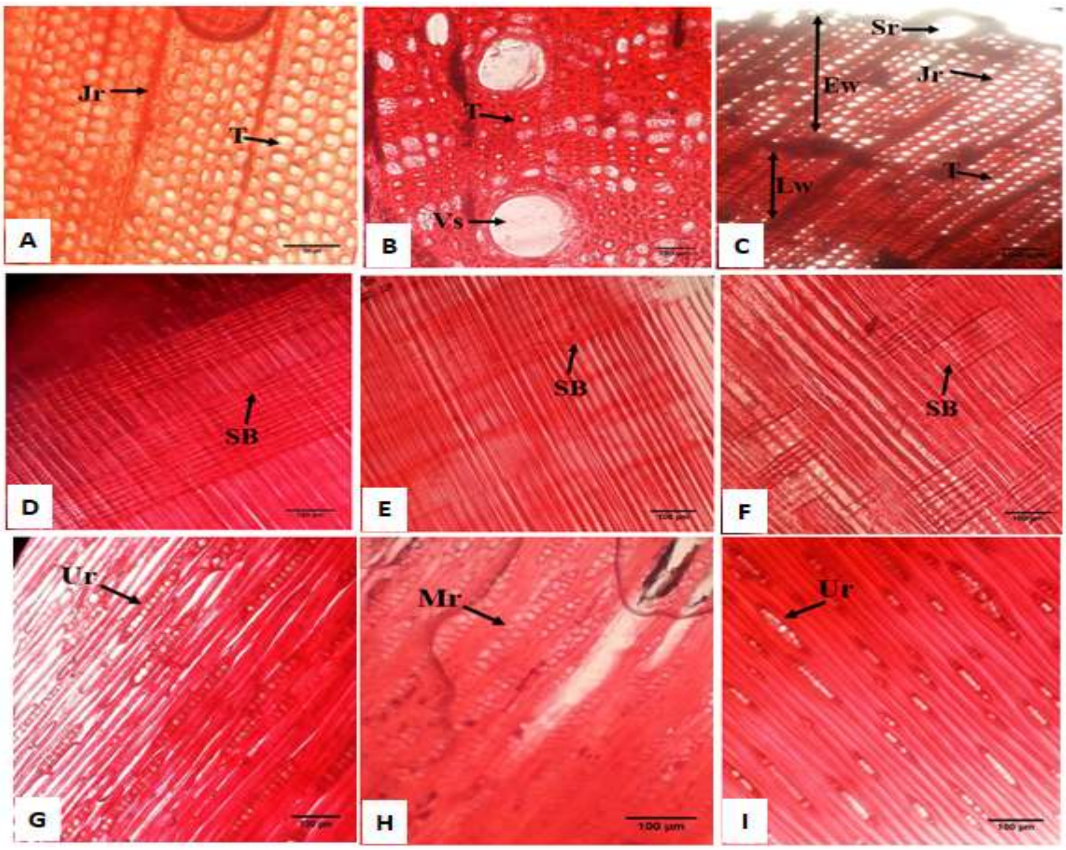

Figure 2.Section of wood. (A-C) Transverse section: (A) Araucaria heterophylla, (B) Casuarina equisetifolia, (C) Pinusmerkusii; (D-F) Radial section: (D) Araucaria heterophylla; (E) Casuarina equisetifolia; (F) Pinusmerkusii; (G-I) Tangential section:(G) Araucaria heterophylla; (H) Casuarina equisetifolia; (I) Pinusmerkusii.T: Trakeid, Ew:Early-wood, Lw: Late-wood, Jr. Ray, Vs: Vessel, Sr: Resin duct, SB: procumbentcell,Ur: Uniseriate ray, Mr: multiseriate ray.

IV. CONCLUSION

The following conclusions can be drawn based on the results:

A growth ring was only found in Pinusmerkusii, while in both Araucaria heterophylla and Casuarina equisetifolia, no growth ring was found.

Earlywood and latewood were found in Pinusmerkusii but not in Araucaria heterophylla or Casurinaequisetifolia. All three coniferous tree species have only precumbent cells. Casurinaequisetifolia and Pinusmerkusii have uniseriate ray type while Araucarinaheterophyllahas multiseriate ray type. Araucaria heterophylla and Casuarina equisetifolia have short category fiberslength,Pinusmerkusii has medium category fibers length.

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