Deterioration of wood exposed to mangrove ecosystem

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Abstract. Deterioration of three types of wood, namely meranti wood (Shorea spp.), mahoni wood (Swietenia mahagoni) and damar wood (Agathis dammara) in underwater exposure in the mangrove ecosystem investigated. The wood soaked for six months, at a depth of 1.5 meters and salinity 7.3. After six months identification of organisms that attack wood is carried out. The types of organisms found attacking wood samples are Teredo navalis and Balanus sp. The types of fungi found include Paecilomyces victoriae, Scytalidium lignicola, Aspergillus sp., Penicillium corylophilum, Aspergillus fumigatus, Biporalis australiensis, Absidia sp, Aspergillus niger and Phytophthora cryptogea.

1. Introduction

The wood used to meet various needs, ranging from fuelwood to building materials, because it’s a natural resource that easily obtained, accessible to processed, and has a decorative appearance. Besides, the beneficial properties of wood also have a weakness, which is very quickly attacked by biological factors such as fungi, bacteria, insects, and sea worms and mangroves to reduce the strength and lifetime of the wood. Wood can be analyzed from various scientific approaches, such as mechanical properties, physical properties, and chemical properties of wood. The chemical properties of wood will focus more on fiber cells, namely tracheal cells in hardwood and libriform cells in coniferous trees (softwood). Chemical properties of wood generally talk about fiber cells in the microfibrils to the molecular level [1-3].

Damage to the wood on the beach building or ship occurs due to animal attacks, mold decay, impact, heating, chemicals, and weathering. The types of biota that most found living in mangrove forests classified in invertebrates, such as shrimp and crabs (Crustaceans), Gastropods, Bivalves, and Polychaeta [4]. Biota, which is a pest, is also found in mangrove environments such as crabs, barnacles, and caterpillars. Pests are organisms that are considered harmful and undesirable because they cause damage to an ecosystem. Barnacle pests attached to the stem and roots so that it can damage the skin and cause the death of individual mangroves.

Damage to coastal buildings and ships caused by the attack of marine animals or biofouling organisms in the hull. Teritip (Balanus sp) are invertebrate biota attached to wood and other hard objects in the sea and brackish waters, which become the habitat where they attach and look for food. That can cause problems for activities in the sea according to the statement of [5] states that although the attachment of organisms is a natural process, organisms attached to it can colonize human-made structures that cause problems, for example, surface changes. According to [6], the wooden requirements
for ships are resistant to insect attack, the influence of temperature and humidity, solid wood fibers, curvature, durable, available in the required quality, and size.

2. Materials and methods
The research was carried out in Palo 80 village, Tanjung Rejo Sub-district, Percut Sei Tuan, Sumatera Utara dan Laboratorium Teknologi Hasil Hutan, Fakultas Kehutanan, Universitas Sumatra Utara.

2.1. Tools and materials
The tools used in this study were buoys, actual weights, paragon pipes with a thickness of 5 cm, and a diameter of 2 inches, a plastic pipe with a diameter of 2.5 cm, and a plastic mine with a diameter of 1 cm. The material used in this study was a sample of meranti wood (Shorea spp.), mahoni wood (Swietenia mahagoni) and damar wood (Agathis dammara) Measuring 30 cm x 2.5 cm x 5 cm. The chemicals used to identify wood are alcohol, malt extract, cotton, distilled water, and PDA media (Potatoes, Dextrose, Agar).

2.2. Methods
Meranti wood (Shorea spp.), mahoni wood (Swietenia mahagoni), and damar wood (Agathis dammara) measuring 30 cm x 2.5 cm x 5 cm perforated the middle with a diameter of 1.5 cm and given a plastic pipe as board divider. The wood sample that has perforated is then dried for 24 hours at 103 ± 2C and weighed to get the initial dry weight of the oven. Then the test sample is assembled with a rope attached to the hole in the test sample (Figure 1). Previously measured the quality of the waters of the mangrove area, namely the measurement of physical and chemical parameters in the waters of the mangrove area by measuring water sanitation in the area by using a hand refractometer. The method of testing wood resistance to attacking organisms at sea refers to [7]. The wood soaked for six months, at a depth of 1.5 meters, and 7.3 salinity. After 6 (six) months, the test sample was removed, the surface is cleaned and dried to dry. The dry test sample is divided into 2 (two) equal parts on the thick side, then the wood damage and intensity of the attack are examined. The intensity of the attack obtained through the following formula:

\[ IS(100\%) = \frac{LA}{LB} \times 100\% \]  

Where:
IS = The intensity of the attack in the wood sample
LA = the surface area of attack
LB = the total surface area of the test sample.

Then do the observation and identification of the organisms that attack the wood samples.

3. Results and discussion

3.1. Identification of wood destroying organism
Two types of wood-destroying organisms are in wood samples, namely types of sea worms (Teredo navalis) and barnacles (Balanus sp). Kingdom Classification: Animalia, Phylum: Mollusca, Class: Bivalvia, Order: Myoida, Family: Teredinidae, Genus: Teredo, Species: Teredo Navalis. Teredo Navalis lives in wood submerged in waters affected by tidal waters or brackish waters. Teredo navalis enters the wood through the barnacle holes. Teredo navalis makes wood as a source of food and as a place to live. Boat worms are marine and estuary organisms that inhabit a variety of submerged wood substrates, including driftwood, ships, or jetties. Part of the sea worm larvae stage was spent swimming freely in the water. Teredo navalis can tolerate low salt levels (up to 5 ppt) and develops at a higher rate of 9 ppt. The optimal temperature range is 15-25 0C and can found in temperate and tropical regions [8,9]. The larvae of this organism are free to move in water and attach to submerged poles and wood, then pierce
the wood and enter the wood. Once in the wood, these animals continue drilling and breakthrough enough wood for their growth [10].

Figure 1. *Teredo navalis* (a) and taxonomy of *Teredo navalis* (b).

Damage to beach buildings and ships also caused by the attack of marine animals or biofouling organisms in the hull section, such as *Balanus* sp. [5] state that although organism attachment is a natural process, attachment organisms can colonize human-made structures that cause problems, for example, changes in wood surfaces.

Figure 2. Teritip or barnacle (*Balanus* sp.).

Classification of *Balanus* sp. was a kingdom (Animalia), phylum (Invertebrate), class (Crustacea), ordo (Thoraceae), family (Ballonoidae), genus (Balanus), species (*Balanus* sp.). Teritip/barnacle (*Balanus* sp) is an invertebrate biota that attaches to wood and other hard objects in the sea and brackish waters, which is the habitat where it attaches and looks for food. *Balanus* sp is a type of crustacean class with white to reddish-brown characteristics. On each shell, there are 3-4 white strips formed from lime, have a soft side, and at the top gaping blunt. The dominance of *Balanus* sp is due to the release of arthropodine compounds so that the same barnacle species will gather and grow until there is accumulation.

The *Balanus* sp colonies attached to the wood leave white marks on the wood surface and do not cause significant damage to the wood. *Balanus* sp makes wood as a substrate that can be used as a nest to stick. Table 1 shows the average value of resin wood with an intensity of attack (IS) 1.24% included in class 1, the average intensity of the attack <7%. The intensity of the attack is very resistant, and the average surface area covered by barnacles is 70.16 cm².

The average value of attacks on meranti wood is 1.74% and belongs to class I with a very high intensity of the attack. The surface area covered by barnacles is 61.16 cm². At the same time, the average value of attack intensity on mahogany wood is 12.69%, with attack intensity in the range of 7-27%
included in class II, including resistance the average value of mahogany wood surface area covered by barnacles 91.16 cm².

| Species   | The intensity of wood attack value (%) | Class | Intensity interval attacks (%) | Endurance   |
|-----------|---------------------------------------|-------|-------------------------------|-------------|
| Damar 1   | 1.72                                  | I     | <7                            | Very resistant |
| Damar 2   | 1.64                                  | I     | <7                            | Very resistant |
| Damar 3   | 0.37                                  | I     | <7                            | Very resistant |
| Meranti 1 | 2.65                                  | I     | <7                            | Very resistant |
| Meranti 2 | 2.08                                  | I     | <7                            | Very resistant |
| Meranti 3 | 0.5                                   | I     | <7                            | Very resistant |
| Mahoni 1  | 15.05                                 | II    | 7 – 27                        | Resistant   |
| Mahoni 2  | 5.72                                  | I     | <7                            | Very resistant |
| Mahoni 3  | 17.32                                 | II    | 7 – 27                        | Resistant   |

High damage wood is mahoni wood because it is a type of softwood and is usually used for paper, musical instruments, cabinets, and other household furniture so that this wood is not suitable for construction in mangrove waters. [11] states that if there are two choices of wood species that are attacked, the destructive organisms will tend to choose softer wood. The results showed that damar and meranti wood had a low attack intensity when compared to attacks on mahogany wood because damar wood has a high specific gravity of 0.72. Besides, the low intensity of attacks on damar wood is suspected because it has silica content. [10] state that marine animals (marine borer) live from wood, which they digest with the help of cellulose, and from plankton, which is abundant in seawater.

3.2. Identification of fungi
The results of the identification of fungi are carried out macroscopically on PDA and microscopic media using a light microscope and refer to the book Pictorial Atlas of Soil and Seed Fungi [12]. Three types

Figure 3. *Teredo navalis* attack on A) damar wood; B) meranti wood and C) mahogany wood.

Figure 4. *Balanus* sp attack on A) damar wood; B) meranti wood and C) mahoni wood.
of fungi have been isolated in damar wood, namely Paecilomyces victoriae, Scytalidium lignicola, and Aspergillus sp. Identification of fungi in meranti wood produces three types, namely Penicillium corylophilum, Aspergillus fumigatus, and Biporals australiensis. The results of the identification of fungi on mahogany wood are four types, namely, Paecilomyces victoriae, Absidia, Aspergillus niger, and Phytophthora cryptogea.

Table 2a. Results of fungal identification of wood exposed in mangrove ecosystems.

| Isolate                        | Macroscopic | Microscopic | Characteristics                           |
|-------------------------------|-------------|-------------|-------------------------------------------|
| Paecilomyces victoriae        | ![Image](image1) | ![Image](image2) | Conidia is brownish yellow and round       |
| Aspergillus fumigatus         | ![Image](image3) | ![Image](image4) | The diameter of the colony is 3-5 cm, conidia are dark green and round. |
| Scytalidium lignicola         | ![Image](image5) | ![Image](image6) | Colony diameter of 2-3 cm, and white to yellowish. Conidia are semi-round. |
| Penicillium corylophilum      | ![Image](image7) | ![Image](image8) | The diameter of the colony is 3-7 cm, the conidia are brownish-gray, and the head of the conidia is round. |
| Biporals australiensis        | ![Image](image9) | ![Image](image10) | Conidia are jet black and round.           |

Note: (a). Conidia, (b). Conidiofor
### Table 2b. Results of fungal identification of wood exposed in mangrove ecosystems (Continue).

| Isolate             | Macroscopic | Microscopic | Characteristics                                           |
|---------------------|-------------|-------------|----------------------------------------------------------|
| *Aspergillus* sp    | ![Image]    | ![Image]    | Colony diameter 3-5 cm green and semi-round in shape. Conidia's head is dark green |
| *Absidia*           | ![Image]    | ![Image]    | Conidia are gray to brownish-gray and round.             |
| *Aspergillus niger* | ![Image]    | ![Image]    | The diameter of the colony is 4 -5 cm, the conidia are black, and the colony is round. |
| *Phytophthora* cryptoceg * | ![Image] | ![Image] | Conidia are white, and the shape of the colony is round. |

Note : (a). Conidia, (b). Conidiofor

### 4. Conclusions

The types of organisms found in the waters of Percut Sei Tuan are *Teredo navalis* and *Balanus sp*. Damar wood and meranti wood are categorized as very resistant to Teredo navalis with an average intensity of 1.24% resin and meranti wood with an intensity of attack of 1.74%, while mahogany categorized as resistant to *Teredo navalis* organisms with an average attack intensity of 12 69%.

The type of fungi that are well insulated on resin wood is *Paecilomyces victoriae*, *Aspergillus sp*, and *Scytaledium lignicola*. Meranti wood, there are 3 types of fungi, namely *Penicillium corylophilum*, *Aspergillus fumigatus*, and *Biporalis australiensis* and in mahogany there are 4 types namely *Paecilomyces victoriae*, *Absidia*, *Aspergillus niger*, and *Phytophthora cryptogea*.

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