Biodiversity of Termites and Fungi in Two Botanical Gardens in Batam, Riau Island Province and Kuningan, West Java Province

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Abstract. Termites and fungi play an important role through promotion of essential ecological processes in ecosystems such as soil modification and rehabilitation, also decomposition of lignocellulosic materials. However, termite is also known as pest toward vegetation, while fungi can also cause bio-deterioration problems. Biodiversity evaluation of termites and fungi are essential for sustainable management and area planning of botanical garden. Hence, this study reviews the importance of recording biodiversity of fungi and termites in botanical garden in Batam, Riau Island Province and Kuningan, West Java province. The research was conducted by active searching method or exploration on termites and fungi on selected plot areas in the aforementioned botanical gardens. The result of this study indicated that biodiversity of termites and fungi were high on selected areas. The presence of termite and fungi in the ecosystem might beneficially support the ecosystem. However, further studies on ecological condition, soil type and climate need to be addressed to determine their influences on biodiversity of termites and fungi.

1. Introduction
A botanical garden is a conservation area dedicated to collection, cultivation, and display of a wide range of plants labelled with their botanical names. The botanical garden may contain specialist plant collection from particular parts of the world. As an ex situ conservation area, botanical garden might serve as botanical research, environmental education, ecotourism and ecosystem services. In addition, a botanical garden may initiate society awareness and appreciation on environment, animals and plants; then protection on the organisms could be approved.

Botanical garden is artificial ecosystem created to support the protection of macro- and microorganisms. As an artificial ecosystem, some organisms may support ecosystem growth and development or even lead to detrimental effect in particular condition. Abandoned population growth of particular organisms could generate the ecosystem destruction.

In this study, we assessed the biodiversity of organisms that frequently observed assigning negative impact on ecosystem. Termite and fungi, mostly Basidiomycetes, are essential components for ecological process in ecosystem. The two organisms play significant roles in decomposing organic materials, being food sources, and recycling process in forest. Furthermore, decomposition of organic materials by termite creates carbon dioxide circulation in the soil; hence contribute to carbon dynamic
in ecosystem, particularly in agriculture, of tropical or sub-tropical countries [1-3]. More than 4000 termite species have been recognized and distributed throughout the world. As much as 2600 species classified in some families and genus, and only 10% of termite species is recognized as pest [4].

Basidiomycetes fungi are the most common and important wood-inhabiting fungi in forests. These species can account for the majority of fruit bodies found on woody debris [5]. The fungi degrade cellulose and lignin as the main component of plant cell wall, hence mostly recognized as decomposer or detrivores the organic materials. Three wood-decaying fungi are grouped based on infestation type [6]; white-rot, brown-rot and soft-rot fungi. All fungi decease the wood quality, such as strength, visual appearance, physical and chemical properties.

However, conversion of forest into agriculture, urban areas, plantations, and industrial areas has generated the change of ecosystem, hence it influence the biodiversity of those organisms and their functions as pest and deteriorating agent.

This study explored the biodiversity of termite and Basidiomycetes fungi in two developing Botanical Gardens; Batam and Kuningan. The information is essential for sustainable management and area planning of those botanical gardens.

2. Material and Methods
2.1. Sampling site

Sampling site was in Sundaland area, in which Batam Botanical Garden and Kuningan Botanical Garden are located. The Batam Botanical Garden is located in the eastern part of Sumatera island; Riau Province, while the other one is located in the western part of Java island; West Java Province. In each botanical garden, sampling site was divided into some areas, which contribute to different vegetation and soil type. In Batam Botanical Garden, the sampling site was in three areas, termed as arboretum, mangrove and forest. Then, sampling in Kuningan Botanical Garden was conducted in four areas, termed as A (dark humic soil), B (red soil/garden), C (red soil near reservoir), and D (boundary forest) area.

2.2. Biodiversity of termite
2.2.1. Termite sampling

Termites were sampled using active searching method. A standardized protocol, belt-transect, was applied for termite sampling [7, 8]. The transect was 100 m long and 2 m wide, and divided into 40 contiguous sections (each sub-transect 5 x 1 m) and numbered sequentially. Each sub-transect was sampled one trained person for each 30 min (Figure 3). In order to standardize sampling effort, the collectors worked steadily and continuously for searching the following microhabitats: surface soil, litter and humus at the base of trees and buttress root, inside of dead logs, tree stumps, branches and twigs, the soil within and beneath rotten logs, all termite nests and mounds, and so on. Termite collection should consisted of soldier and worker for further identification. All termite samples were kept in EtOH.

Figure 1. Belt-transect method for termite sampling, which consist of sub-transect area (A1 – A3 and B1 – B3)
2.2.2. Identification of termite
The termite sample was identified based on morphological characters of head, abdomen, mandible, body and antennal shape, tarsal segment, tibia and femur [9-11].

2.3. Biodiversity of fungi
2.3.1. Fungal sampling
Fungi were sampled by active searching method. The fungi were explored in each sampling site for one to one and half hours to search the main target of fungal fruit body. The collected fungi were kept in paper bag for further identification.

2.3.2. Identification of fungi
As fungal identification, the collected fungi were isolated and grown in laboratory before identification. First, the fruit body was sterilized in sodium hypochlorite 5% for five minutes, then rinsed with distilled water before air-drying in ambient temperature for two to 12 hours. The dried sample was transferred into potato dextrose (PDA) agar media in Petri dish. The Petri dish was then incubated in ambient temperature for three to seven days [12]. The grown fungi on PDA media were identified based on characters of macroscopic morphology, of which mushroom body, pileus, stipe color change, texture, odor, and veil presence were characterized [13].

3. Results and Discussion
3.1. Biodiversity of termite
In Batam Botanical Garden, 207 samples of termite were collected from three sampling areas, and 200 samples were collected from four areas of Kuningan Botanical Garden. In identification, termite samples were classified in functional group, which is based on known feeding habits [14-15] or worker gut content analysis. Protozoa associated with termites indicated the functional group of termites; lower and higher termites. In all species of Lower termite genera harbor throughout most of their lives faunules of flagellate protozoa in the hindgut [16], which affect their feeding habit. The species of Lower termites feed on sound or nearly sound wood. In contrast, the higher termites, Termitidae, that either lack intestinal flagellates have a rather varied diet consisting of wood (much more decayed wood that taken by the Lower termites), dried grass, leaves, or in fact most other vegetable material. In addition, this family may ingest soil and extract from it useful nutrient. The diversity of termite species in each sampling site of botanical garden is described in Figure 2 and Figure 3.

![Figure 2. Termite collection in Batam Botanical Garden](image-url)
Figure 3. Termite collection in Kuningan Botanical Garden

The higher termite was the dominant termite found in both botanical gardens. Based on the feeding habit of higher termite, which feed on mostly decayed materials, termites found in two botanical gardens mainly played their function as detrivores. Detrivores contribute to decomposition and nutrient cycle, hence these roles are an important aspect of many ecosystem. In addition, the existence of higher termite in ecosystem may prove as ecological indicator. In ecology perspective, the higher termite is more vulnerable toward ecosystem changes compared to Lower termites [17]. They are much more susceptible to the fluctuations in microclimate that accompany habitat disturbance, particularly involving forest canopy disruption. Hence, the dominancy of higher termite in an ecosystem might indicate that the two botanical gardens are considered as undisturbed areas with natural composition.

3.2. Biodiversity of fungi

Fungal samples from Batam Botanical Garden were collected as much as 36 samples from three sampling areas, and 65 samples were collected from four areas of Kuningan Botanical Garden. Identification of fungi based on morphological characters of the fruit body or the spores, which illustrated according to family group (Figure 4 and Figure 5).

Figure 4. Fungal collection from in Batam Botanical Garden
Figure 5. Fungal collection from in Kuningan Botanical Garden

Polyporaceae was the dominant fungi found in both Botanical Garden. The polyporaceae are a family of poroid fungi belonging to Basidiomycetes. The abundance and richness of polyporous fungi in an ecosystem connect with the amount of coarse woody debris, not with fertility gradient of the ecosystem [18]. The amount of large dead wood in one of the most important factors for fungi and fungi-inhabiting species [19]. The polyporous fungi are sensitive to environmental changes and required specified substrate. Thus, the coarse wood debris plays a key role for providing the structure for natural fungus community. The existence of the coarse woody debris are commonly associated with the main characteristic of natural forest. Hence, the abundance of polyporous fungi in an ecosystem might indicate its condition as natural ecosystem. Now, the polyporous fungi are used increasingly in management planning of forest as indicators of naturalness in conservation.

4. Conclusion
The biodiversity of termite and fungi in both botanical garden; Batam and Kuningan Botanical Garden were high in selected areas. The higher termite was found as dominant genera in both botanical garden, while polyporous fungi was the main fungal community in either Batam or Kuningan Botanical Garden. The presence of those termite and fungi in the ecosystem might beneficially support the ecosystem.

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