Pests and diseases on forest plant in burned peatlands in South Sumatra

Asmaliyah1, E E Hadi1, and R S B Irianto2

1 Environment and Forestry Research and Development Institute of Palembang, Jl. Kol.H.Burlian Km 6,5 Puntikayu, Palembang, South Sumatra, Indonesia
2 Forest Research and Development Centre, Jl. Gunung Batu No.5, Kotak Pos 165, Bogor, West Java, Indonesia

Email: asmaliyah-bp2ht@yahoo.com

Abstract. At present most of the peatland in the OKI district, South Sumatra was damaged by forest fires. One way to restore the condition and function of peatlands as before is to rehabilitate by replanting suitable species on peatlands. One of the obstacles to the planting success on peatlands is the presence of pests and diseases. This study aims to determine pests and diseases of forest plants in several locations of burned peatlands in South Sumatra. The method used in this study was a survey method by direct observation of sample plants. Parameters observed were species of insect pests and pathogen, incidence and intensity of the attack. The results showed that several insect pests and diseases were found on burned peatland in Ogan Komering Ilir district, South Sumatra and identified as Cycnotrachelus sp., Valanga nigricornis, bagworm, Daphnis hypothous, Macrophoma sp., Pestalotiopsis sp., and Cephaleuros sp. The highest incidence of bagworm attacks was on Shorea balangeran and categorized as very heavy damage. The highest intensity was occurred on Dyera lowii that were attacked by Cephaleuros sp. and was categorized as moderately heavy damage. Even though the pest and disease attacks brought no economic losses, they must be watched closely by continuous monitoring.

1. Introduction
Indonesia is one of the tropical countries hold the largest peatland in the world encompass about 21 million hectares spreading across Sumatra, Kalimantan and Papua [1]. The largest peatlands are in Sumatra Island, which mostly spread along the east coast of Riau, South Sumatra, and Jambi. In South Sumatra, the largest peatlands are in Ogan Komering Ilir (OKI) district covering 698,000 hectares [2]. Currently, most of the peatland in the OKI region has been damaged by unsustainable forest exploitation practices and wildfires, leading into open cogen grassland, shrubs and small lakes [3].

One way to improve and restore the condition and function of peatlands is rehabilitation by replanting peatlands with suitable species such as ramin (Gonystylus bancanus Kurz.), Jelutung rawa (Dyera lowii den Berger), and meranti (Shorea balangeran) In general, the success of planting are often held back or even wipeout by pests and diseases. Pests and diseases control in the plantation will succeed if the information about the pests and diseases attacking the plants in peatland are identified.

However, The information on pests and diseases attack peat lands plantation are still limited. Therefore, this study was conducted to find out the species of pests and diseases found in burned peatlands in OKI district including the intensity and the extent of attacks. This information is expected...
to be used as one of the references in the management of plants on burned peatlands to control pests and diseases attack.

2. Materials and Methods

2.1. The Research Site
The research was carried out in two locations of rehabilitation plots of burned peatland forests in Ogan Komering Ilir (OKI) district, South Sumatra. The locations were in Pulau Geronggang village, Pedamaran Timur sub-district, OKI district on deep peat swamp (> 300 cm) covering 2 hectares (3°37'25.3'S 105°11'02.3'E) and in Kutaraya village, Kota Kayuagung sub-district, OKI district with on shallow to medium peatland (50 cm-200 cm) encompasses 3 hectares (3°23'25.5'S 104°51'36.8'E).

2.2. The Research Method

2.2.1. Inventory of pest and diseases
Observation plots were made up to 20% of the total available area. Observation plots were subsequently divided into small plots of 20 x 20 m in Geronggang village and 20 x 30 m in Kutaraya village. Plots were laid down in the middle and corners of the location. Observations and data collection was carried out by a census on each observation plot. Parameters observed were symptoms, species of insect pests and pathogen. Pest identification was carried out in the Zoology Entomology Laboratory, Research Center For Biology, Indonesian Institute of Sciences and a book of Kalshoven (1981) [7]. While identification of pathogen was carried out in plant clinics, Department of Plant Protection, Faculty of Agriculture, IPB.

2.2.2. Measurement of incidence and intensity of the attack
Data of incidence and intensity of attack were collected by census on each observation plot. Parameters observed were the number of plants attacked, the total number of plants and the number of plants attacked from each attack category. Incidence of an attack was obtained by using the formula:[4]

\[ LS = \frac{\text{The number of plants attacked in a observation plot}}{\text{The total number of plants in a observation plot}} \times 100\% \] ...................................................

\[ \text{Incidence} \]

Meanwhile, intensity (I) was obtained using following formula: [4]

\[ I = \frac{\sum (Ni \times Vj)}{\sum (Z \times N)} \] ...................................................

\[ \text{Intensity} \]

Remarks:

I : Intensity
Ni : The number of plants attacked from each attack category
Vj : Scale value of each attack category
Z : The highest scale value of each attack category
N : The number of observed plants in each observation plot
Table 1. The score value of each attack category

| Score | Symptom of damage on plant | Attack category |
|-------|----------------------------|-----------------|
| 0     | no attack                  | Healthy         |
| 1     | affected leaf area ≤ 25%   | Mild            |
| 2     | affected leaf area > 25% - 50% | Moderately heavy |
| 3     | affected leaf area > 50% - 75% | Heavy          |
| 4     | affected leaf area > 75%   | Very heavy      |

3. Results and Discussion

3.1. Insect Pest and Diseases

Based on the observations, several species of insect pests and diseases were found in two locations of burned peatland in Ogan Komering Ilir (OKI) district, namely:

3.1.1. Cycnotrachelus sp. (Coleoptera; Brenthidae)

The insect pests of *Cycnotrachelus* sp. beetle which belong to the family of Brenthidae and the Coleoptera class, were leaf-eating pests found in several forest plants on peatlands, including pulai swamp (*A. pneumatophora*), jelutung swamp (*D. lowii*) and punak (*Tetramerista glabra*). The *Cycnotrachelus* sp. was a reddish brown beetle with black patches on its wings, it has a snout in front of its mouth, possesses a long prothorax, and its elytra isn't longer than its thorax. The body length generally ranges from 6-17 mm [5]. The beetle's activity occurs during the day. It attacks the leaves by broaching shoots and young leaves, but are also found often in old leaves. The affected part of the leaf will become dry (brown) afterward and then fall off. The beetle attack causes leaves to become hollow while in severe attacks, young shoots and leaves fall off (figure 1).

![Figure 1. The symptoms of attack from *Cycnotrachelus* sp. on the punak plant (a), pulai swamp (b) and the *Cycnotrachelus* sp. beetle (c)](image)

3.1.2. Valanga nigricornis (Orthoptera; Acriididae)

*Valanga nigricornis* Burm. (wood grasshopper) is one of the grasshopper species which develop very rapidly because of its wide host range, relatively high fecundity and has wide distribution areas in southern Thailand, Malaysia, Indonesia and in the Philippines [6]. Fecundity *V. nigricornis* reaches an average of 158 eggs per female [7]. Wooden grasshoppers (*V. nigricornis*) are eating actively from morning to evening, very greedy of both young (nymphs) and adults. Adult grasshoppers usually eat leaves starting at the edges, while nymphs eat between the vein leaves creating holes in leaves. In severe attacks, the grasshoppers are able to consume all the leaves up to the petiole [8,9].

The wood grasshoppers are commonly found on peatlands because the environment in peatlands is suitable to breed and grow [10,11]. The grasshopper's attack on young plants of *Shorea balangeran* were observed in Kutaraya village, Kayuagung district covering large damage area. It was also found on *S. blangeran* seedlings in the seedbed of Tumbang Nusa, Central Kalimantan [12] and *Acacia crassicarpa* seeds aged 1-3 months in the seedbed of PT. Inhutani III, Banjar Baru, South Kalimantan, Indonesia [13].
The colors of the nymphs are light green/pale green. As for the adult, grasshoppers are greenish yellow, yellowish brown or green with dark blue hues, especially on its wings. The rear femur enlarges, its antenna is short (filiform), has a thorn in the lower part of the prosternum and was smaller in the anterior than the posterior (figure 2). The female body size (58-71 mm) was larger than the male (49-63 mm). The adults lay eggs in the dry season and hatch at the beginning of rainy season. Eggs are laid in the soil at a depth of 5-8 cm. Living in hot areas on bushes and trees [14].

3.1.3. *Pteroma plagiophleps* (Lepidoptera; Psychidae)
*Plagiophelps pteroma* was a small size bagworm, polyphag, attacks many tree species and could be found at various levels of plant age. The bagworm attacks observed on jelutung swamp (*D. lowii*) and in *S. blangeran* stand in OKI district. It was also found in *A. crassicarpa* seeds that grow on peatlands [13]. The bagworm attack occurs both in dry and rainy seasons [15]. Bagworm attacks were generally characterized by holes in the surface of the upper leaves, initially yellow, then turns brown like as it was burned, and eventually falls off [16]. Attacks on seedlings could cause the seeds to be bare. Bagworm attacks were also found eating stems that are used to make pockets [17].

*P. plagiophelps* larvae make bags from silk threads and material from plants (leaves, twigs) attached to the host plant (figure 3). Larvae live in the pouch and only the head goes out with a pair of legs that lie in the first segment of the thorax through the anterior hole when it moves and eats. The feces is removed through the posterior hole. The Caterpillar grows in size along with the increase of its bag size. Pupation occurs in the bag and the pupa will hang on the host plant and is covered with silk thread (16,18). The grown insects are brown-gray colored with a wingspan of 6-22 mm wide. The grown males have wings that come out of its bag, while females do not have wings and stay in the bag [18].

3.1.4. *Pagodiella* sp. (Lepidoptera; Psychidae)
The *Pagodiella* sp. bagworm, which belongs to the class of lapidoptera and the Psychidae family, has the characteristics of a bag shaped like a pagoda, it has a trait of polyfag and often found in forest plants. The attack of this caterpillar species was found in jelutung swamp (*D. lowii*) both on peatlands and seedlings also in grown stands and in *Shorea blangeran*. Bagworm attacks are dominantly found in the dry season [15,19].
Pagodiella sp bagworm. attack plants by eating the green leaves or by its flesh leaving the epidermis and the veins uneaten. As a result, the attack causes the leaves to perforate and will dry out and eventually fall off (figure 4). The size of the hole varies depending on the size of the Pagodiella caterpillar, as the caterpillar grows in age, it will get bigger and the attacked part of the leaf will also get wider, and so as the hole. Severe attacks of this bagworm can cause the seedlings to shed making the growth of the seedling inhibited. Severe damage occurs if there are 2-3 caterpillar populations per seedling because the surface area of the jelutung leaves that is being attacked or damaged is quite extensive.

![Figure 4. The attack of Pagodiella sp bagworm on jelutung swamp plants (a) and S. blangeran (b)](image)

3.1.5. Daphnis hypothous (Lepidoptera; Spingidae)
Daphnis hypothous was a leaf-eating pest found in jelutung rawa (D. lowii) and Shorea blangeran plants in a 2-year-old stand. D. hypothous caterpillars attack plants by eating all parts of the leaf except the primary vein (figure 5). The attack causes the leaf surface area and the photosynthesis rate to decrease. It was also found attacking jelutung swamp seedlings in its seedbed in Gasing village, Talang Kelapa sub-district, Banyuasin regency and in the seedbed of the Environmental and Forestry Research and Development Center delaying the seedling growth and even causing death since no leaves on the seedlings [20].

![Figure 5. D. hypothous on the jelutung rawa seed (a), symptoms of attack on S. prince (b) and moth (c).](image)

D. hypothous caterpillar has a thick body, hairless, green with yellowish white lines along the sides of its body, at the end of the abdomen, there is a cercus patch about 0.4 cm long in size and in the metathoracic segment there is an eyespot (ocelli) with a blue color. Entering the preparation stage the body of the larvae turns brown. The pupa is brown with a length of about 6 cm [21]. The grown caterpillar are large, nocturnal, have brown bodies and wings with blackish brown spots, long and narrow front wings, strong aviators, have a long proboscis, and have the ability to migrate long distances [22]. These pests have wide distribution areas in Southeast Asia, Indonesia (Java, Sumatra), Australia [6] and India [23].

3.1.6. Cephaleuros sp.
Cephaleuros sp. was a plant parasite from the Trentepohliaceae tribe (green algae) which has a wide host distribution [24] and is often found in thick leaves such as tea, coffee and pepper [25,26].
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Observations of algae parasites were found in ramin plants (*Gonystylus bancanus*), jelutung swamp (*D. lowii*) and punak (*Tetramerista glabra*) on peatlands. This algae attack is found in leaves, petioles and primary leaf vein and plant branches with symptoms of red patches, therefore it is often known as red spots (figure 6). [26] reported that *Cephaleuros* sp. grows on living leaves and other parts of woody plants. The algae form an orange-red substance called hematochrome and have carotene and chlorophyll. *Cephaleuros* has one or two disk-shaped talus layers extending between the cuticle and leaf epidermis. *Cephaleuros* algae are weak parasites, it only attacks weak plants (poor nutrients, poor drainage and lack of water). *Cephaleuros* have a wide distribution in tropical and subtropical regions [24,27].

The algae attack plants by inserting threads into plant tissues, then it removes toxins and kills plant cells until they form red spots. Infection and developing symptoms occur in humid conditions. The effects of this pathogen attack reduce photosynthesis, deciduous leaves, dead ends on dieback and dead tissue (necrosis). Pathogens reproduce and survive in patches of leaves or stems and remaining plants that have fallen [27].

**Figure 6.** Symptoms of *Cephaleuros* sp. on jelutung swamps (a), ramin (b) and punak (c)

### 3.1.7. *Macrophoma* sp.

*Macrophoma* sp. was a fungal pathogen that was found attacking a 2-year-old *Piper* (*Tetramerista glabra*) plant on peatland. The attack of pathogen *Macrophoma* sp. causes brown leaf spots on the leaf surface and at the bottom of the leaf. At first, the spots are small, with irregular patterns, over time the spots will enlarge covering the entire leaf surface (figure 7). The result of this pathogen attack can cause a reduction in the effective area of the leaf surface for photosynthesis, making the leaves dry out and fall off eventually. In advanced attacks can cause the death of plants, especially in young plants.

The microscopic characteristic of the fungus pathogen is that it has a cylindrical, clear conidia (hyalospora) and is formed in picnidia or acervulus in a considerably large amount. The picnidium color is dark, a bit hard, stromal and mostly perforated [28].

**Figure 7.** Symptoms of leaf spot attack caused by pathogen *Macrophoma* sp. on the punak plant (*T. glabra*): the surface of the leaf (a) and the underside of the leaf (b)

### 3.1.8. *Pestalotiopsis* sp.

*Pestalotiopsis* sp. was one of the pathogens of leaf spot disease which was also found in the jelutung rawa (*D. lowii*) plant on burned peatlands in Kutaraya village, Kayuagung district. This pathogen
attack was also found in seedlings and in young A. crassicarpa [29] plant and meranti (S. balangeran) [30]. In general, the infection caused by leaf disease pathogens from fungal and bacterial groups will develop rapidly in environmental conditions that have high humidity and with water that stagnates around the stem and leaf for a long time. Therefore, these pathogens are most commonly found in locations where it rains frequently or places with high humidity.

The symptoms of the disease caused by this type of pathogen on the leaf surface, contain brown spots with irregular patterns. These spots will develop by age, with the middle part drying out brown and gray (Figure 8). Furthermore, the infected leaf will dry out and fall off, causing the leaf to perforate. Microscopically, it was seen that the conidia of Pestalotiopsis pathogens are in the form of coils with some bulkheads and hyaline [31]. This pathogen was a weak parasite that infects through wounds.

3.2. Incidence and Intensity

The observations on the extent and the intensity of the attack can be seen in the following table. Table 2 shows that the incidence of pest and pathogen attacks varies from mild to severe attacks. The attack of the bagworm on the S. balangeran plant has the highest incidence and is classified as very severe attack, followed by the pathogen attack by Cephaleuros sp. on jelutung rawa and punak plants and the Cycnotrachelus sp. in pulai rawa plants classified as severe attacks. The lowest incidence occurred in D. hypothous attacks on jelutung rawa plants. The intensity of all pests and pathogens is still relatively low, except for the attack of pathogen by Cephaleuros sp. in the jelutung rawa plant (D. lowii) belonging to the moderately heavy attack category. Therefore, this pathogen attack must be constantly monitored regularly, because with the condition of the inundated land, continuously and by a long time can highly support for the growth and reproduction of Cephaleuros sp. pathogens in the future. In Sarawak, this pathogen causes disease in pepper trees which is quite detrimental, so control efforts are needed [25].

The controlling activity to anticipate the pathogen attack of Cephaleuros sp. so it will not spread and develop can be done in several integrated ways [27], namely, 1) sanitation by eliminating mildly attacked leaves using hand, collecting leaves that fall off due to diseases, and demolishing it by burning, 2) pruning the branches to reduce moisture or to accelerate drying after rain, 3) reduce plant stress by applying fertilizer and improve soil drainage, 4) cleaning the area from disturbing plants (weeds), 4) planting tolerant plants that can grow on wet environment, 5) adjusting spacing and thinning to improve aerase and light exposure, and 6) if needed fungicides can be used as suggested.

Attacks on bagworms also need to be constantly watched. Although the intensity of attacks is still considered as a mild attack category, the extent of attacks is classified as very severe. In addition, bagworms are a dangerous pest. The results of study showed that P. plagiophelps bagworm attacks on A. crassicarpa seedlings at PT. Inhutani III, Banjar Baru, South Kalimantan caused economic losses [13]. As for the results of other researcher showed that Pagodiella sp. is one of the pests that cause the most damage to mangroves in the Arboretum which causes seeds and young plants to be leafless [32].
**Table 2.** Incidence and intensity pest and diseases in burned peatland in OKI

| Location | Disturbing organism | Host | Incidence (%) | Intensity (%) |
|----------|--------------------|------|---------------|---------------|
| 1        | *Cycnotrachelus* sp. | a. Pulai rawa (*A. pneumatophora*) | 55.79 | 12.5 |
|          |                    | b. Punak (*T. glabra*) | 33.33 | 10 |
|          |                    | c. Jelutung rawa (*D. lowii*) | 25.98 | 10 |
|          | *Valanga nigricornis* | | 44.19 | 14.74 |
| 2        | *Cephaleuros* sp. | a. Ramin (*G. bancanu*) | 27.91 | 11.36 |
|          |                    | b. Punak (*T. glabra*) | 68.94 | 23.75 |
|          |                    | c. Jelutung rawa (*D. lowii*) | 69.48 | 47.07 |
|          | *Pestalotiopsis* sp. | | 37.21 | 18.59 |
|          | *Pagodiella* sp. | a. Jelutung rawa (*D. lowii*) | 38.46 | 10.89 |
|          |                    | b. *Shorea. Blangeran* | 81.42 | 8.27 |
|          | *Pteroma plagiophelps* | a. Jelutung rawa (*D. lowii*) | 25.64 | 8.98 |
|          |                    | b. *Shorea blangeran* | 92.1 | 9.47 |
|          | *Daphnis hypothous* | a. Jelutung rawa (*D. lowii*) | 20.51 | 14.06 |
|          |                    | b. *Shorea blangeran* | 31.71 | 6.42 |
|          | *Cephaleuros* sp. | a. Ramin (*G. bancanu*) | 28.74 | 11.35 |
|          |                    | b. Jelutung rawa (*D. lowii*) | 44.19 | 29.79 |
|          | *Macrophoma* sp. | | 25.58 | 10.62 |

1. Location in Geronggang village, Pedamaran Timur sub-district, OKI district
2. Location in Kutaraya kelurahan, Kayuagung sub-district, OKI district

The method of control that can be done to suppress the widespread and development of bagworm attacks is by implementing several ways of integrated control, such as 1) collecting caterpillars by hand or light trap to catch butterflies / grown-ups, then exterminate them, 2) using active microbial bioinsecticides, *Bacillus thuringiensis* bacteria which can be directly applied or in combination with neem plant-based insecticides, and 3) if needed chemical insecticides can be used with 75% active acetate, with a dose of 2-3 grams/liter by spraying method. However, biological control using bioinsecticides is preferred especially in peatland ecosystem, because it is relatively environmentally friendly and cheaper than chemical insecticides and also practical.

4. Conclusion
There are 5 species of insect pests and 3 species of pathogens found on burned peatlands in OKI regency, South Sumatra, namely *Cycnotrachelus* sp. Beetle, *Valanga nigricornis*, *Pagodiella* sp., *Pteroma plagiophelps*, *Hypothous Daphnis*, *Cephaleuros* sp., *Macrophoma* sp., and *Pestalotiopsis* sp. The highest area of attack occurred in bagworm pest attacks on *S. blangeran* plants and the lowest attack area occurred in hypothous Daphnis caterpillar attacks on jelutung rawa plants. The highest attack intensity occurs in *Cephaleuros* sp. on the jelutung rawa plant. Losses due to attacks of bagworms and pathogens *Cephaleuros* sp. has not been seen clearly, however, the attack needs to be monitored continuously, given the extent and the intensity of the attack is quite high and its potential status as a pest which is quite dangerous. By monitoring continuously can anticipate early if there is an
increase in the attack status of insect pests and pathogens so that it won’t develop wider and detrimental

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