Herbivorous Insects Associated with Albizia (*Falcataria moluccana*) Saplings in Bogor

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Abstract. *Falcataria moluccana*, commonly known as albizia or sengon, is a native plant of Maluku, New Guinea Island, the Bismarck Archipelago and the Solomon Islands. Sengon trees are cultivated in many areas, including Java and Sumatra, mostly for raw material of plywood. Despite its importance for timber production, information regarding the insects associated with sengon saplings in Java is very limited. The objective of this study was to identify the insects associated with sengon saplings in Bogor. The study was conducted in Carangpulang village, Bogor, West Java. Observations of insect herbivores were made every 2 weeks between 14 and 32 weeks after planting. Fifty-one species of herbivorous insects from 26 families and 4 orders were collected from sengon saplings. Leaf eating insects belonging to the order Lepidoptera were the dominant herbivores. Three spot grass yellow butterfly, *Eurema blanda* (Lepidoptera: Pieridae) larvae was the most abundant insect found on the saplings, causing heavy leaf damage.

Keywords: phytophagous insect, key species, sengon

1. Introduction

Community timber plantations are production forests built by individuals or groups of neighbors to generate income and improve the potential availability and quality of forest products. A community timber plantation can be used as part of a local empowerment program which can increase farmer's income by producing firewood, building materials and industrial raw materials, fruits, tubers, medicinal materials, vegetables and fodder, while also allowing the community to maximally utilize and sustain otherwise unproductive lands and accelerate land rehabilitation efforts [1,2]. The increasing management of forest product development through community timber plantations is expected to lead toward local forest sustainability and improved economic growth in rural areas of Indonesia.

The initial step in producing a community timber plantation is the growth of seedlings and saplings. Healthy seedlings are key in producing quality saplings and the effort to achieve successful planting of forest plots [3] to increase the economic value and productivity of the plants [4]. Intensive management of seedling nurseries can greatly reduce the impact of pests with relatively low costs due
to the high density of plants in a small area. However, once the sapling is planted in the field by the farmer, damage caused by insect herbivores is harder to manage. Insect pests can impact the productivity of plants directly through feeding on various plant parts and cause damage to the newly planted sapling which can reduce tree growth and survivial [5]. A better understanding the types of insect pests and their abundance can lead to solutions to the problem of growing healthy trees once they leave the nursery.

Falcataria moluccana also known as sengon or albizia is an exceptionally fast-growing tree in the family Fabaceae [6]. It is a native of the Maluku Islands, New Guinea Island, the Bismarck Archipelago and the Solomon Islands but the tree has been grown for commercial uses in many areas including Java and Sumatra at least since 1871 [7]. It is grown in Indonesia in small holder community forestry plantations and in large-scale industrial plantations primarily for plywood, but also for pulpwod, matchsticks, light-weight packing materials and local timber products (firewood, construction materials, etc.) [8,9]. Based on the latest data from Jakarta’s Badan Pusat Statistik agency BPS [10], sengon is the timber species with the largest production after Acacia spp. and Shorea sp., with 2.62 million m$^3$ of wood produced or 5.97% of total timber production in Indonesia. This tree has been widely planted throughout the world as an ornamental tree and for reforestation but has become an invasive species in some environments [11].

Data regarding the diversity and abundance of insect herbivores associated with sengon saplings is very limited. The information available is mostly from large scale commercial sengon plantations and tends to be restricted to the early stages of seedling production or from mature plantations. The most important pest that attacks sengon plantations or natural stands of trees greater than one year old is the stem borer Xystrocera festiva (Coleoptera: Cerambycidae). This insect attacks live trees often causing mortality and has become a serious pest in Indonesia, Malaysia but is not found in plantations in India [12]. The next most important insect pests are the bagworm Pteroma plagiophleps and the caterpillars of the grass yellow butterflies (Eurema spp.) [13]. Beside these pests, other insects found in sengon plantations are mostly leaf feeders including other caterpillars of several families of Lepidoptera, and Chrysomelid and Curculionid beetles [14]. Outside the native range of sengon most of these insects are generalist plant feeders and very rarely reach the level of damage to achieve pest status.

The pest inventory is an important management tool that should be done before taking insect control steps [15]. This is important because an error in identifying the pest may result in additional expense controlling minor insect herbivores that have no longterm economic impacts on the trees. Knowing which insects are present can also avoid additional pest control problems by identifying natural enemies that are already present or can be introduced to control the pests without the use of costly pesticides [16]. The purpose of this study was to identify of the insect herbivore diversity and abundance to determine the important pests on the sengon saplings that are the same age as the trees typically planted in community timber plantations.

2. Materials and methods
Sengon seeds from a plantation in Leuwisadeng, West Bogor, West Java, Indonesia were used for this experiment. Seeds were pretreated by soaking in tap water for 24 hours and then were immediately placed into flats [17]. Soil flats were completely saturated with water in a sterilized soil mixture comprised of top soil (20%), compost (40%), and husk (40%) [18]. The soil in the flats was allowed to evaporate for 3 days after sowing the seeds and then watered as needed daily. After sufficient growth (approximately 3 to 5 weeks) the seedlings were transferred into polybags filled with a mixture of top soil (50%), compost (30%), and husk (20%). Seedlings were kept in a greenhouse and manual removal of insects was done to minimize exposure to pests prior to the start of the experiment.

Three-month-old greenhouse raised sengon test plants were transplanted into 40 cm x 40 cm polybags in the field, retaining as much of the original potting mix as possible. The remainder of each polybag was filled with field topsoil (a mixture of sandy clay) for a total of 5 kg of soil. Polybags were watered and afternoon rains also provided additional soil moisture on the day of transplant.
Observations were held every 2 weeks for 5 months (plants age 14 until 32 weeks after planting) following transplant to the field. Each observation recorded the herbivorous insect species, the abundance of insects and plant part attacked. Direct observations included all parts of the test plants, from the stem up to the apical meristem, branches, and the upper and lower surfaces of leaves. Some insects were collected by hand picking or using an insect net to be used for voucher specimens and more detailed identification. Insect larvae were also caught and then put in a plastic bag which is then taken to the laboratory for rearing to adulthood to confirm identity.

Voucher specimens from each observation period were prepared and identified from samples kept in liquid (70% ethanol) or dried and pinned for preservation. The scale insect specimens were preserved on microscope slides for identification using standard techniques [19]. Insect identification was based on morphology and was taken to the lowest possible taxonomic level possible, preferably to species level. The dichotomous keys from standard entomology reference books [20-22] were supplemented with additional online dichotomous identification keys and multi-access Lucid keys [20].

3. Results
The overall abundance of insect herbivores associated with the sengon 14 to 32 weeks after planting included 926 individuals (table 1). The diversity of our observations consisted of 4 orders (Coleoptera, Hemiptera, Lepidoptera, and Orthoptera), 26 families, and 51 species. Most of these insects attack the plant leaves (data not shown). The larval phase was the most common development stage of the insects observed (table 1).

Table 1. The insect herbivores associated with sengon saplings 14 to 32 weeks old.

| Order       | Family | Species              | Phase | Abundance |
|-------------|--------|----------------------|-------|-----------|
| Coleoptera  | Chrysomelidae | Arthrotus histrio | Adult | 2         |
|             |        | Diapromorpha pinguis | Adult | 2         |
|             |        | Gastrophysa viridula | Adult | 1         |
| Coleoptera  | Coccinellidae | Bucolus fourneti | Adult | 1         |
| Curculionidae |       | Dyschères curtus | Adult | 8         |
|             |        | Polydrusus formosus | Adult | 5         |
| Elateridae  |       | Melanotus rufipes | Adult | 2         |
| Lycidae     |       | Metriorhynchus sp. | Adult | 1         |
| Scarabaenidae |     | Phyllophaga rugans | Adult | 1         |
| Hemiptera   | Alydidae | Homoeocerus marginellus | Adult | 1         |
|             |        | Leptocorisa acuta | Adult | 8         |
|             |        | Leptocorisa oratorius | Adult | 2         |
|             |        | Riptortus linearis | Adult | 5         |
| Coccidae    |       | Parthenolecanium corni | Adult | 9         |
| Flatidae    |       | Siphanta patruelis | Adult | 1         |
| Margarodidae |     | Margarodes sp. | Adult | 12        |
| Membracidae |       | Anchon ulriforme | Adult | 1         |
|             |        | Gargara genistae | Adult | 18        |
|             |        | Leptocentrus taurus | Adult | 4         |
| Pseudococcidae |   | Ferrisia virgata | Adult | 21        |
| Psyllidae   |       | Acizia uncatoides | Adult | 5         |
We found that the 10 most abundant species and ranked these species based on the number of individual observed: *Eurema blanda* (Lepidoptera: Pieridae), *E. hecabe* (Lepidoptera: Pieridae), *Ferrisia virgata* (Hemiptera: Pseudococcidae), *Schistocerca pallens* (Orthoptera: Acrididae), *Gargaragenistae* (Hemiptera: Membracidae), *Pteroma plagiophleps* (Lepidoptera: Psychidae), *Hulodes caranea* (Lepidoptera: Noctuidae), *Margarodes* sp. (Hemiptera: Margarodidae), *Choristoneura* sp. (Lepidoptera: Tortricidae), and *Parthenolecanium corni* (Hemiptera; Coccidae).

In addition to the most abundant insects we found that there was a wide variety of feeding strategies as these pests attacked the sengon saplings (figure 1). The larvae of the yellow grass butterfly *E. blanda* had the highest abundance and damage level, causing the plants to lose leaves from their gregarious larval feeding (figure 2). Similarly *E. hecabe* caterpillars attack leaves, but their solitary feeding does not damage the plant as much as *E. blanda*. The bagworm, *P. plagiophleps*, has...
characteristic leaf damage from their feeding on the bottom leaf surface which forms hollow cavities between leaf veins. These caterpillars also attack the surface of fresh green stems and branches, especially when their populations reach high densities. The leaf-rolling caterpillars of *Adoxophyes* sp. (Lepidoptera: Tortricidae) and *Choristoneura* sp. use young leaflets to make protective shelters and feed on the surrounding leave material. In severe attacks the plant undergoes defoliation ultimately leaving only rolled up leaves. The caterpillars of *H. caranea* starts feeding from the leaf edge causing the leaves to be reduced, they also eat the lower surface of the leaves when they are hiding from predators. The scale insects *P. corni* and *Margarodes* sp. and the mealybug *F. virgata* are true bugs that feed on the leaf petioles, stem and fresh branches by sucking the plant sap. The weevil *D. curtus* (Coleoptera: Curculionidae) eats the leaves from the edge in irregular notches. The grasshopper *S. pallens* (Orthoptera: Acrididae) chews on shoot tips, young leaves, and the surface of young stems.

**Figure 1.** Some species of herbivorous insects cause the most damage to sengon. *E. balanda* (a); *E. hecabe* (b); *P. plagiophleps* (c); *Adoxophyes* sp. (d); *Choristoneura* sp. (e); *H. caranea* (f); *Margarodes* sp. (g); *F. virgata* (h); *D. curtus* (i) and *S. pallens* (j).
Eurema blanda (Lepidoptera: Pieridae) become important pests and can cause the worst damage to the plant. These larvae have the highest abundance (658 individuals) of all the insects observed. The caterpillars are the pests that pose a greatest threat on sengon saplings because they form groups that attack young leaves and leaf tillers which can lead to leaf loss and eventual plant death (figure 2c). The adult of E. blanda is yellow with 3 black spots on the ventral front wing (figure 2b). Adults very quickly located the newly transplanted saplings and were observed to be ovipositing on the sengon plants the first day in the field.

![Image](image.png)

Figure 2. E. blanda larvae (a); adult (b) and leave damage (c).

4. Discussion
Some of the dominant pests of saplings from our study such as E. blanda, E. hecabe, P. plagiophleps, and F. virgate have also been reported as pests in other stages of sengon tree production [13, 23]. These insects can become serious pests in sengon plantations, although only E. hecabe, and P. plagiophleps are reported to cause significant economic damage or impact mature tree survival [24]. Pteroma plagiophleps and Hyblaea puera (Lepidoptera: Hyblaeidae) were found to be the most dominant pest insects attacking sengon seedlings in West Lampung, Surachman et al. [25] but we did not find the later species in our field plots. A few of most abundant species in our study like H. caranea, Margarodes sp., Choristoneura sp. and Adoxophyes sp. have not been reported from sengon before and represent new host records.

The most important pest on sengon saplings was the larvae of E. blanda. The caterpillar population tends to increase along with the size of the sengon saplings. This is because E. blanda which lay their eggs on the surface of leaves in a group of up to 300 eggs in a batch [26]. The caterpillars are gregarious and stay together while feeding on the leaves which can dramatically increase the damage. The abundance of E. blanda can also be due to the relative shortness of the life cycle with a generation time of 26 days to reach reproductive age and a total life cycle of about 36 days [13]. This insect occasionally causes severe defoliation in Java, but usually the infestation is transient and the damage not serious in older trees [27].

In addition, larvae E. hecabe is also an important pest in sengon seedlings, but on saplings this species not as serious a pest as E. blanda. This is because their behavior of laying only a few eggs per plant and the solitary lifestyle of the larvae. Both E. blanda, and E. hecabe are polyphagous insects and have 36 days for total life cycle [13]. The influence of E. hecabe attacks on sengon seedlings has
been studied by Wulandari [28]. A total of 500 sengon seedlings were kept in the nursery and allowed to be attacked by E. hecabe naturally. During the one month study 2 periods of attack occurred. In the first period of attack 12.24% of the seedlings had E. hecabe larvae while only 3.45% of the seedlings were attacked in the second period. We also found E. hecabe caterpillars and pupae on our seedlings in the greenhouse but regularly removed them to prevent damage before outplanting for the sapling field experiment (data not shown).

The polyphagous larvae of P. plagiophleps can cause severe damage to sengon trees. Feeding on the leaves begins with small hollow which spreads into a net-like striping of the leaflets also causing yellowing and eventually defoliation of the leaves [29]. This species has a total development time of 2 months for male insects and 2.5 months for the females [30]. Aprilia [23] reported P. plagiophleps severe attack on sengon trees in Bogor occurred towards the dry season in April-June 2001. Suhaendah et al. [31] reported a multi-year outbreak of P. plagiophleps on a 5 year old sengon plantation in Tasikmalaya, West Java from 1994 to 1997. This species also reported to kill about 22% of 3-6 years old trees in a Sumatra plantation [32]. In Kerala, India P. plagiophleps was present in sengon plantations throughout the year and leading to heavy defoliation [30]. Mathew and Nair [33] mentioned in their research in Kerala, India, P. Plagiophleps killed 22% of sengon trees aged 3-6 years for over 3 years in a 20 ha plantation.

Ferrisia virgata are polyphagous mealybugs that attack sengon seedlings in nurseries and young plants by sucking the plant sap and injecting toxic saliva which causes branch drying and shoot death Aprilia [23]. The females live for 1-2 months but adult males only live for 1-3 days. Female insects are able to lay eggs from 200 to 450 eggs [34]. This insect is found in a relatively large number of sengon seedlings and generally attack on the stem and bases of leaves. So far there has been no report on the economic damage caused by this pest, however with great numbers of mealybug attacking petioles or branches they can cause leaf fall [35].

Understanding the diversity of herbivorous insects on sengon can help small stakeholders and farmers make the best pest control management decisions. We found that the damage caused by E. blanda could quickly expand and cause severe loss of leaves and may lead to tree death. Fast action to stop the growth and spread of these caterpillars by removing young batches of larvae by cutting off the infested leaflets or direct application of pesticides could have a larger benefit than treating any of the other insect species. Alternative management of other pest species might include the manual removal of these insects from small saplings. Use the grasshopper S. pallens as part of the traditional diet can also serve to improve tree growth. Also the planting of understory crops for agroforestry to take advantage of nitrogen fixing ability of sengon will have the added benefit of encouraging the diversity of natural enemies around these trees to prevent pest outbreaks.

Acknowledgements
The results presented here are part of the Albizia Biocontrol Project, financial support by United States Department of Agriculture - Forest Service. Grateful thanks are due to Lia Nurulalia (Bogor Agriculture University) for her help in larvae identification.

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