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The Bioecology Study of Shoots Driller Pest (Moore) (Lepidoptera, *Pyralidae)* on five Meliaceae Plants in *North Sulawesi*

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Abstract: The destruction of forests or economical forest products occurs when the insect population rises to a certain extent. The high degree of insect populations that damage depends on the value of forests. Therefore, in order to protect forest plants from damage it is important to understand the principle of the rise and fall of insect populations. The height of Mahogany's branch, which is attacked by pests, decrease compared to normal. As the consequence, the volume of the main logs at maturity level is smaller than normal volume. The pest attack also causes the emergence of many tree branches and a decline in the selling price of the wood from a tree that was attacked. Slowdown occurs because of an attack on the young shoots of plants by *Hypsipyla robusta* (Moore) (Lepidoptera, Pyralidae). The highest attack by *H robusta* on the plant is in the area of Bitung, North Minahasa, Tomohon and South Minahasa which is above 70%, while the lowest percentage of attacks lies in the Talaud and Kotamobagu Regency. The insects likes is the little mahogany leaf. Statistically, thereis significant difference rate between significant treatment between small mahogany leaf and broad mahogany leaf although the favorite level has reached above 90%. The significant difference is also seen between the treatment of small mahogany leaves and mindiduku leaf and Langsa with a difference level of more than 70%.
Keywords: *H robusta.* Mahogany, Meliaceae.

I. Introduction

Plant intruder organism (OPT) is a risk that must be faced and taken in any crops to improve the products in line with expectations. This risk is a consequence of changes in the ecosystem as a result of cultivation. Climate variability is a matter that must be accepted as a natural phenomenon which is very influential on the development of the pest and directly affect the cultivation of plants. A pest explosion occurred due to one or more factors. An abundant source of food all the time is accompanied by changes in climate. The destruction of forests or economical forest products arises when the insect population rises to a certain extent. The high degree of insect populations that damage depends on the value of forests. By pressing an insect population, the economical damage can be eliminated. Therefore, in order to protect forest plants from damage it is important to understand the principle of the rise and fall of insect populations[1].

The population increase in the world which is followed by the development of various sectors may lead to increased forest product needs, which in turn threatens the sustainability of the world's environment. To overcome these problems, there isa need of forest industry, so that the demand of wood raw material can be met continuously without damaging the existing natural forests. There are three requirements that need to be considered in the selection of industrial forest tree species, i.e.: the benefits, the availability of seed and growth capabilities. Based on the above three requirements, mahogany has a bright prospect to be developed as the forest industry.

The economical mahogany wood *(Swietenia macrophylla* King)is originated from the Amazon Basin, south part of Brazil, Bolivia and Peru[2]. In Indonesia, *S. Magahoni* is first planted in Java in 1879 (Lahiya,)[3]. The planting of *S. macrophylla* in Indonesia is possiblyoccurred after years mentioned above. Currently, mahogany has been planted widely in Indonesia and used as crop afforestation, reforestation and for the planting program GNRHL (National Movement for Forest and Land Rehabilitation). Most seedlings are derived from the seeds, because the propagation is easy to do.

One factor that is suspected as a limiting factor of the declining quality of mahogany standis the presence of pests and tree-disease-causing agents. Forest pests are all animals that destroy forests and forest products through the activities of life and cause economic loss[4]. Mahogany stands pests, higher branch-free trunk on average has decreased compared to normal standing. As a result of the volume of logs principal at maturity cut smaller than normal standing volume of the same age. The pest attack also resulted in the emergence of many tree branches and caused a decline in the selling price of the wood from a tree that was attacked.

The mahogany slowing plant growth for a sufficiently long period occurs in almost the entire planting area in Indonesia. The **s**lowdown occurs because of an attack on the young shoots of plants by *Hypsipyla robusta* (Moore) (Lepidoptera, Pyralidae). The stems curved and formed lateral branching / sideways since the release of secondary shoots resulting from the death of the apical / terminal shoot[5]. Based on observations in the field, throughout the Minahasa, Bitung and Bolaang Mongondow, Tomohon and Manado, the affected plants are young plants with height range between 1 m - 4 m.

Given the high and the value of the forest, the forest conservation efforts must be done whatever the consequences that must be faced, because in fact the increase in productivity and the preservation and protection of forest actually has long-term goals, therefore it is necessary to find a proper solution to maintain productivity stands or forest ecosystems[6].

According to Iskandar[7], as exotic species, there are some weaknesses in handling mahogany shoot borer pest. The geographical circumstance in Indonesia which is an archipelago makes this condition difficult to control the distribution and transport of plants and animals between islands. The other drawbacks are the lack of information about foreign species, limited human resources who have knowledge of species invasive, the lack of coordination between institutions, and undeveloped-program at the national level in addressing species invasive in the forest. Due to the mahogany shoot borer attack, in 1998 there has been a 40% mahogany crops damage that are two to five years old. However, the effective management of *robusta hypsipyla* has not yet been achieved[8].

The insect preferences and development of various types of host plants are varied and depends on the quantity and quality of primary and secondary chemical compounds on host plants. The primary compounds contain nutrients, while the secondary compound works as a stimulant to eat and have no nutritional value for insects[9]. In order to study how to prevent and control the pests well and the ecological impact, the research on bio-ecology of mahogany shoot borer needs to be conducted.

II. Research Methods

1. Place and Time Research

Research to study the population dense and the intensity of the attacks is carried out in all districts / cities in North Sulawesi. While the research of *H robusta* preference to five Meliaceae plants is carried out in Laikit village, Dimembe district, North Minahasa Regency. The morphological characteristics study is

conducted at the Pests and Diseases Laboratory, Faculty of Agricultural, Unsrat. The research was conducted for 1 (one) year, i.e. June 2012 to June 2013.

2. **Research Tools and Materials**

The tools that are used in this study includes: aluminum stairs, insect nets, microscopes, glass, loupe, test tubes, petridicbowls, confinement gauze, dissection tools (forceps, needles, knives), bottles collection, sharp-tipped glass pipette with rubber, soft brush, bottle berpipet, aqua plastic cups, plastic buckets, cameras, GPS and stationery pipette. The plant materials (samples) that are used in this research are *langsat*, duku, mindi, large mahogany and small mahogany, alcohol 90%, cotton, rubber, plastic bags, fine gauze, paper labels, tissue, raffia.

3. Research Methods

The method used in this research is descriptive analytic method. The research to determine the intensity of the attacks uses the formula:

$I = n / N \times 100\%$

While research to find out the preferences of the *H robusta* to the five meliceae plants is done by using a Latin square design of 250 plants with LSD test. The food preferences of imago testing will be done with the same species tested on larvae. The five types of plants planted in plastic containers are inserted into the insect net with a size of 10 m x 10 m x 2 m. Seven hundred and fifty pupaeare put in a cage. Pupasare placed diagonally while each place is put 150 pupae as shown below.

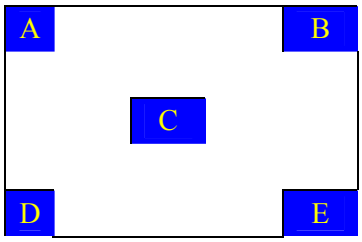

Figure 1.Pupa Laying Patterns

The observations on damaged shoots due to young larvae that come out of the eggs laid by imago are conducted for 2-4 weeks. This study is designed in a Latin square design with 5 treatments and 5 replications. Total number of plants in the entire treatment plant is 250. The study is conducted over seven months. The food preference of imago test is a continuation of the first phase of the testing phase. The difference is the upper part of insect net cover is opened, it is to attract insects *H robusta* from the outside. The whole plant is in trim to produce new shoots. The new buds are expected to invite the insects to lay eggs.

III. Results and Discussion

In Figure 2, the highest *H.robusta* attack to mahogany plant shoots percentage is in Bitung area (79.05%), Tomohon (77.04%), North Minahasa (75.28%), southern Minahasa (72.57%), Minahasa (68.33%), Manado (51.43%), Minahasa southeast (50.20%), Bolaang Mongondow (38.05%), East BolaangMongondow (36.11%), Talaud (15.4%) and Kotamobagu (7.16%).

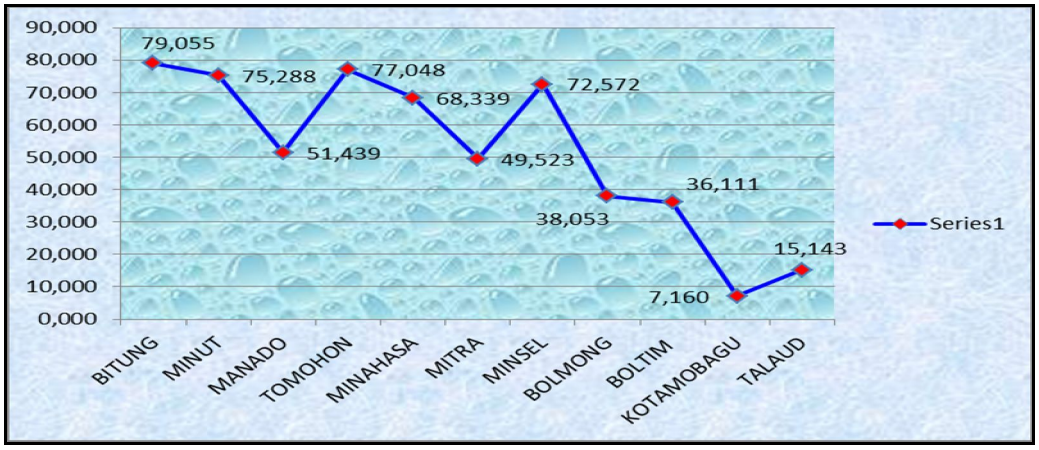

Figure 2.The percentage of *H.robusta* attack on plant shoots

The H.robusta attack on the plant shoots the highest in the area of Bitung, North Minahasa, Tomohon and South Minahasa are above 70%. While the lowest percentage of attacks lies in the area Kotamobagu and Talaud Regency.

The Figure 3, shows that only a few plants are not attacked, i.e. in Kotamobagu region (81.66%), Talaud (28.33%), Manado (6.66%), East Bolaang Mongondow (6.66%), Southeast Minahasa (5%), Bolaang Mongondow (3.33%), while in other areas such as Bitung, North Minahasa, South Minahasa, and Tomohon Minahasa, all samples of the plants have been attacked. The **h**igh percentage of not-attacked-plants in Kotamobagu is probably because there are not many mahogany plants in Kotamobagu while the crops are not attacked in the East Bolaang Mongondowand Southeast Minahasa because many plants have hard buds.

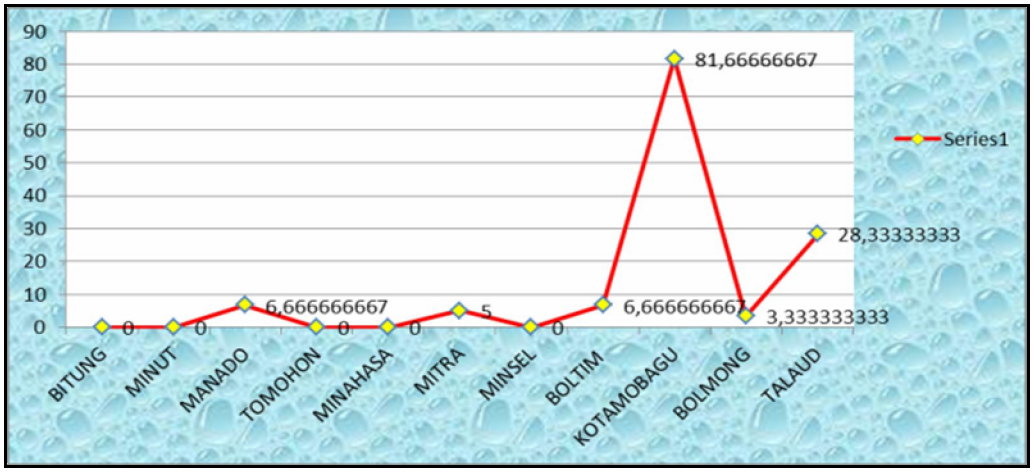

Figure 3.The percentage of *H.robusta* attack on mahogany plant

The figure 3, shows that the lowest of insects *H robusta* is in Kotamobagu. This might be due to the weather and environmental factors that do not support the development of *H robusta.* The environmental factor is the availability of food or host for *H robusta. H robusta* pest is reported as a pest that only likes mahogany plants even though there are indications that it can attack the mangrove family *melieacea.* At the high population, the intensity of the attacks will reach to the leave bone. This is because, in general, the adult female lays eggs in some places and the first instar larvae will eat the young shoots or leavebone before enter and hoist plant shoots. When the larvae are already in the bud, the other larvae will move to find another host.At this moment, *H robusta* is vulnerable to predators. Although the larvae will generally move but also 3-4 larvae are found in each shoot. All parts of the plant are still soft (shoots, stems, branches and leaves).

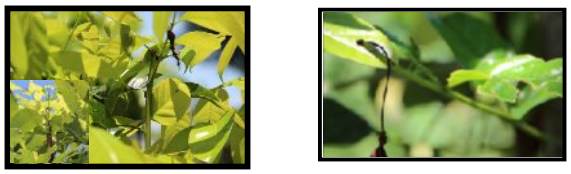

Figure 4. *H robusta* attack on shoots and bone leaves.

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The successive attacks on the plant will result in a lot of plant shoots, slow growth and will be the host of insect *H.robusta*. The severe attack will result in many plants shoot or resemble a "broom". Besides the plant growth will not be same. Plants that experienced a severe attack will experience growth disorders or will not produce the expected wood or even crop failure. The uneven growth or slower growth in mahogany plant is due to recurrent attacks of *H robusta*. However, the effective management of *Hypsipyla robusta* has not been achieved yet[8] .

In general, imago *H robusta* will lay eggs on young shoots or soft shoots compared with that hard. This is related to nutrition of larvae at the time began to eat so as not to move to another part of the plant, then at the time of observation, there are several research areas which have low-intensity attacks. In addition, there are some imago females which lay eggs on twigs. At heavy attack, mahogany trees would be difficult to develop or cannot produce the expected timber anymore. The young shoots that grow will continue to be the host of *H robusta* continuously. As a result, the affected plants do not grow maximum weight but the attack of *H robusta* plant do not cause death of mahogany. The stem growth becomes curved and form lateral branching / sideways since the release of secondary shoots is resulted by the death of the apical / terminal shoot[5].

The young shoots that are available will remain a favorite host of *H robusta* so the population of this pest is increasing. But even the food availability is abundant, in certain circumstances the population could decline. This is probably caused by environmental factors. At violent attacks, the2-3 insect larvae can be found in a plant shoot. Very wide distribution of insect species can be found both in lowland and highland. The attacked plants are not just the young plants, but the plants above the age of 5 years if it has young shoots, it will still be attacked.

In general, the hoist holes will be covered by frass and silk threads. It is possible to prevent predators into the plant shoots. Yet there are often centipedes in a hoist pit with dead larvae. If the larvae have left the hoist holes and become adult then along the hoist will be a dry hole and often there is black mycelium mushroom. In general, the larvae will hoist the shoots of plants to complete a life cycle although there is also a move to the top of another. But the probability is small. The absence of insects in the shoots can be seen in the presence of bright yellow frass if the larvae are still in bud but if the color of frass has become brown, it means they has stopped eating or pupae formation. If the color of frass is very brown and there is a hole, then the larvae have become imago.

Figure 5. The new phrase and old phrase

The presence or absence of insects in the shoots can be seen in the presence of frass bright yellow if the larvae are still in bud but if the color has become brown frass means has stopped eating larvae or pupae formation. If the color of frassis very brown and there is a hole, the larvae have become imago. The *H.robusta* attack results in a lot of plant shoots and continuously attacked. As a result, plants cannot produce the expected wood except the mahogany is planted as a shade plant only along the road. All mahogany shoots plant has been attacked by *H robusta* or it can be said that the mahogany plants that are attacked severely enough would live without shoots and free from *attack*of *H. robusta.* All the shoots will die because of the attacks of *H robusta* and new shoots will grow and re-attacked by *H robusta* continuously.

The attack of *H robusta* may occur in mindiand mahogany. Although the attack on mindiis very small and some insects do not complete its life cycle in mindi but move to mahogany. At Mindi, the attack is different.There is no dead plant shoots. Usually there is only broken twigs and the plants do not produce new shoots.

Figure 6. Attack on a mahogany B. Attacks on Mindi

The *frass* color in mahogany and mindiis different. This is because, in general, the color of the insect *frass* will be influenced by food. At the mahogany plant, the *frass* color is yellowish brown whereas at mindi, the frass color is brownish white. The attacked plants will be covered by brownish yellow frass and when the insects have come out into the adult insect (imago) then the former hoist will open or form a hole.

In the high attack, all the formed shoots by the initial attack will be re-attacked, even the branch will be attacked. But in general, the attacked twigs or leaves will not be host of the insects forever or in other words, *H robusta* will not complete its life cycle in one of the branches and will move to the top of another. The time of high-intensity attack and larvae move to other plants is a prone condition to insect predators will attack. The attack on the branch will not result in economic damage because of the insects do not complete its life cycle in the branch plant. This may be influenced by the structure of twigs or nutrient content.

Table 1. Test of significant difference in preference H robusta on Meliceae plants with covered nets

MDK	MDL	Mindi	Duku	LANSA	TREATMENT
C	B	A	D	E	
64.77	60.04	12.44	5.74	5.74	AVERAGE
c	**c**	**b**	**a**	**a**	**Notation**

Based on the data above it can be seen that the highest level of Insects preference is on small leaf mahogany. Statistically, there are significant differences between treatments between small mahogany leaf and broadleaf although its favorite level has reached above 90%. A significant difference is also seen between the treatment of small mahogany leaves and dukumindi leaf and Langsa with a difference level of more than 70%. Fraenkel[9] in the selection of host plants, the role of secondary metabolites is very big. However, at the suitability of host plants, the nutritional value of plants determines whether the food support the physiological processes related to growth and development of larvae, imago long life, and fecundity imago or not[10].

Table 2.Significant difference test of *H robusta* preference on Meliceae plants with open nets

MDK	MDL	MINDI	DUKU	LANSA	TREATMENT
C	B	A	D	E	
85,84	73,50	8,27	5,74	5,74	AVERAGE
c	**b**	**a**	**a**	**a**	**Notation**

In general, insect larvae is very easy to stress so that at the time of discharge from the young shoots, most of them will form pupae that is marked by numerous threads about the larvae. Pupa formation can occur at any place whether it is leaves, twigs or surrounding objects. This may be a defense form of insects.

In Indonesia, the development duration from egg stage to the moth on mahogany shoot lasts for 40 days with 10 days of pupal stage. This insect property and activity is different according to their habitat, which in Indonesia is similar to the case of West Africa, but in contrast to India and Australia. The life cycle of the mahogany shoot pest is five weeks or ten generations per year. While the results of the study in Ibadan, Negeria show that in June to September the insect life cycle is 26-37 days with details for stage eggs, larvae and pupae is 3-5 days, 13-19 days and 10-13 days. In Indonesia, a development from egg stage to the moth on mahogany shoot lastsfor 40 days, where in the pupal stage it is about 10 days[1].

The emerging larvae from eggs will soon eat the parts of trees, i.e. soft buds on the shoots and young leaves up into the veins of the leaves before the hoist shoots. Larvae on the young shoots or young leaves will eat the epidermis part by forming irregular trajectories then select a point on the top and will be broaching down in the pith. In general, the larvae will always stay in one shoots but occasionally move to another bud. This happens because eating out of favor or the size of the tip is too small for the larvae to complete their growth in the bud. The death of the prime shoots indicates repeated attack of larvae on mahogany shoots.

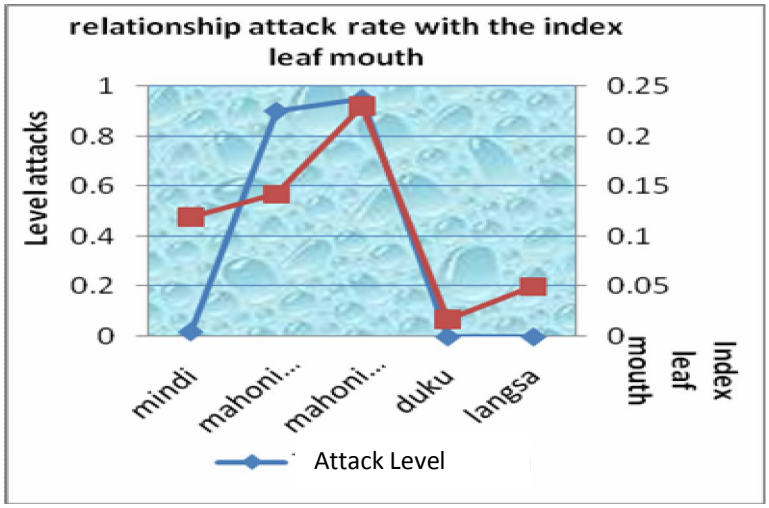

Figure 7. Relationship of attack rate and leaf mouth index

To survive, herbivorous insects need plants as food. The eating activity for insect aims to get energy in order to perform life activities, such as, copulation, migration, growth and reproduction. Basically insects perform a certain activity or behavior so that insects can survive, perhaps including avoidance strategies from predators. Insects are basically like other animals which need energy. If their energy needs are not met we can imagine, the insects will be extinct from the earth's surface. In terms of the evolution, insects are able to adapt to different habitats[11].It shows that the insect has a high adaptability. Plants as herbivorous insectfood can defend themselves against insects by forming a chemical and physical defense. The chemical defenses by forming secondary metabolites are in the form of chemical compounds that are not favored by insects or poisonous to insects. Chemical compounds for defense usually include antixenosys and antibioxys. While the physical plant defenses are trychoma, network violence, etc.[12]

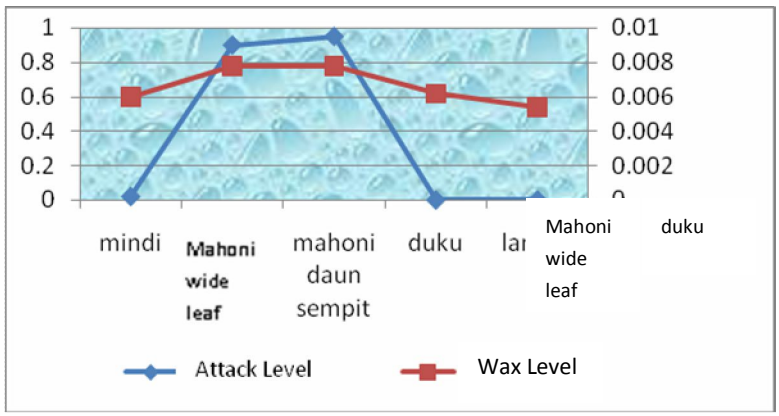

Figure 8. Relationship of attack rate and wax rate

The physical defense properties of plant are generally carried by certain genes. Plants which act as host must be able to provide good nutrition for growth, development and reproduction of insects. With this concept, the eating insect should digest the foods that are not only appropriate with the needs but also has to be able to assimilate and transform it into structural energy and substances for normal activities and developments.

Phytophagus insects have evolved primarily on the mechanisms to overcome the obstacles that belong to the host plant. Activities regarding behavior, biochemistry and physiology are regulated through sensory input. In addition, the *feedback* mechanism of natural physiological and environmental factors makes them able to adapt to changing circumstances. In one side, the plant has to defend itself, but the herbivore insect needs food for survival. So insects must find a way how to overcome plant defenses in a variety of situations, conditions, space and time. The behavior to adapt to the environment is needed by insects to overcome plant defenses barriers, e.g. allelochemistry, physical plants and ecology obstacles womb. This situation means that the insects must be able to break the defenses of plants, both chemical and physical defenses in order to survive.

Insects also have evolved many ways to evade various physical defense such as leaf spines, hairs and trichoma. Although some morphological characteristics of the plant may be towing the insects to lay their eggs. A type of butterfly larvae *Mechanitis isthmia* can circumvent such trichoma by spinning silk hangers so that the larvae can walk and eat the leaves normally.

Conclution

1. The highest *H robusta* attack on the plant shoots is in the area of Bitung, North Minahasa, Tomohon and South Minahasa which attacks above 70%. While the lowest percentage of attacks lies in the area Kotamobagu and Talaud Regency.
2. The highest level of insect preference is on small leaf mahogany. Statistically, there is significant difference between treatments significantly on small mahogany leaf and broadleaf although his favorite level has reached above 90%. A significant difference is also seen between the treatment on small mahogany leaves and duku and langsamindileaves with a difference level of more than 70%.

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