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Host range of *Exallomochlus hispidus* (Morrison) (Hemiptera: Pseudococcidae) in West Java, Indonesia

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Abstract. *Exallomochlus hispidus* (Morrison) (Hemiptera: Pseudococcidae) is a polyphagous mealybug with a wide host range. Many of them are fruits that have high economic value and potential export commodities. In addition, *E. hispidus* is a quarantine pest so that its presence can be an export barrier. The purposive sampling method were used to take plant samples. Host plants were sampled in 4 districts in Bogor, Sukabumi, Purwakarta, and Garut, West Java. Mealybugs and their host plants were put in a paper bag and taken to the laboratory. Adult female mealybugs were prepared microscopically for identification. Results showed that *E. hispidus* was found on 31 species of 18 families. Most of the hosts were fruit crops 54.84% and at least medicinal plant and weed 3.23%. The major host plants are fruit crops including cocoa, duku, rambutan, sapodilla, soursop, mangosteen and lemon. The part of the plant which is inhabited by *E. hispidus* mostly is on the fruit and the least on the stem. The results of this study were expected to provide information on the host range of *E. hispidus* so that it can be prevented from spreading and proper control is taken.

1. Introduction

Exallomochlus hispidus is a mealybug that is found in various kinds of plant. Previously known as *Cataenococcus hispidus*, later changed to *Exallomochlus hispidus*. This mealybug is native to Southeast Asia. There are 41 host plants from 30 families in the Asian region [1], while ScaleNet reports 40 genera from 27 plant families [2]. In Indonesia, this species has been reported by Wirjati in 1950-1959. Wirjati found *E. hispidus* in several host plant such as mango (*Mangifera indica* L.), cocoa (*Theobroma cacao* L.), guava (*Psidium Guajava* L.), rambutan (*Nephelium lapaecum* L.), duku (*Lansium domesticum* Correa), soursop (*Anona muricata* L.), and the namnam (*Cinometra cauliflora* L.) [3]. The various types of host plant include fruit crops, plantation crops, and ornamentals.



Direct damage to plants causes symptoms, such as chlorotic spots on leaves, wilted leaves, curled leaves, dots on the surface of fruit skins, stunted plants, and even plant death. The presence of honeydew resulting from mealybug excretion is a growing medium for black sooty mildew, reducing the selling price of the fruit [4]. Another disadvantage is that these pests can be carried over to post-harvest and are quarantine pests that can hinder Indonesia's tropical fruit exports. As reported by Evans and Dooley, *E. hispidus* is a potential invasive species. This status is obtained based on their pest status, known hosts and distribution, and the number of times they have been intercepted [5].

Information on the host range of *E. hispidus* in Indonesia is still limited. Host range research can help farmers to prevent and control these pests. By knowing the alternative host pests, farmers will apply good agricultural practices to prevent cultivated plants from being attacked by these pests. Therefore, the purpose of this study was to determine the range of *E. hispidus* hosts in West Java

2. Methods

Mealybugs samples were taken from 4 study site, namely Karacak Village, Lewiliang District, Bogor, Babakan Village, Wanayasa District, Purwakarta, Sukawening Village, Sukawening District and Neglasari Village, Kadungora District, Garut West Java in February 2016 - June 2017 (figure 1). The altitude between 500-700 masl. Preparation and identification of *E. hispidus* species were carried out at the Pest Control Laboratory of the Center for Isotope and Radiation Application, National Nuclear Energy Agency (PAIR BATAN).



Figure 1. Maps of study sites in West Java, Indonesia.

A sampling of *E. hispidus* and its host using purposive sampling method. The selected sampling area was an area with lots of fruit trees. Mealybug samples were taken from stems, shoots, leaves, flowers, and fruit except for the roots. Each sample was put into a paper bag and labelled with the name of the collector, date of collection, host and location of the collection. The paper bag was put in a plastic container and taken to the laboratory for further observation. Mealybug samples were placed on a plastic tray and photographed by mealybugs and their host plants. Then count the number of mealybugs present in a host. If the number of adult mealybugs was more than 30 individuals and was found to be repeated in several areas, it was categorized as the most preferred host plant [6]. Also, the part of the plant inhabited by mealybugs observed, including stems, shoots, leaves, flowers or fruit.

For species identification, adult female mealybug specimens were prepared in slide following the protocols from [7], with slight modification by [8]. The mealybugs samples were preserved in 70% ethanol. Mealybugs were macerated using 80% potassium hydroxide (KOH). The stain used is Fuchsin acid. Clearing using clove oil and mounted on Canada balsam. Identification of mealybugs morphologically using [1, 7]. Plant taxonomy refers to the Integrated Taxonomic Information System (ITIS)

3. Results and discussion

3.1. Host range of *E. hispidus*

The mealybug *E. hispidus* is a polyphagous insect with many host plants. The research found 31 plant species in 18 families were recorded as host plant of *E. hispidus* (table 1). Most host plants were found in Purwakarta, namely 20 species in 13 families, followed by Bogor 19 species from 11 families, Garut 15 species from 12 families and the least in Sukabumi there were 14 species from 12 families. The highest number of host plants were family Malvaceae (4 species), Moraceae (4 species), followed by Rutaceae (3 species) and Sapindaceae (3 species) respectively. The other families was only 1 or 2 species recorded as host plant.

Table 1. Host plant of *E. hispidus* in Bogor, Sukabumi, Purwakarta and Garut, West Java.

No	Family	Scientific name	Common name	Plant Category**	Study site***			
					Bo	Su	Pu	Ga
1	Annonaceae	<i>Anona muricata</i> L.	Soursop	Fu	√	√	√	√
		<i>Anona squamosa</i> L.	Sugar apple	Fu	√		√	
2	Arecaceae	<i>Areca catechu</i>	Pinang palm	Me		√		√
		<i>Dypsis lutescens</i> (H. Wendl.) Beentje & J. Dransf.	Yellow palm	Or			√	
3	Asparagaceae	<i>Agave americana</i> L.	American aloe	Or			√	√
4	Caesalpinaceae	<i>Caesalpinia pulcherrima</i> (L.) Sw.	Peacock flower	Or	√	√		
5	Clusiaceae	<i>Garcinia mangostana</i> L.	Mangosteen	Fu	√	√	√	
6	Cucurbitaceae	<i>Sechium edule</i> (Jacq.) Swartz	Chayote	Ve	√		√	
		<i>Cucurbita maxima</i> Duchesne	Squash	Ve	√		√	
7	Euphorbiaceae	<i>Macaranga triloba</i>	Macaranga	Wi				√
8	Fabaceae	<i>Gliricidia sepium</i> Walp.	Gliricidia	Wi				√
		<i>Cajanus cajan</i> (L.) Millsp	Pigeonpea	Ve				√
9	Malvaceae	<i>Durio zibethinus</i> Murray	Durian	Fu	√	√		√
		<i>Hibiscus tiliaceus</i> L.	Tree hibiscus	Wi		√		
		<i>Hibiscus rosasinensis</i>	Rose mallow	Or			√	√
		<i>Theobroma cacao</i> L.	Cocoa	Pla	√	√	√	√
10	Melastomataceae	<i>Melastoma malabathricum</i> L.	Rhododendron	We		√		
11	Meliaceae	<i>Lansium domesticum</i> Correa	Duku	Fu	√	√	√	
12	Moraceae	<i>Artocarpus heterophyllus</i> Lam.	Jackfruit	Fu	√		√	√
		<i>Artocarpus integer</i> (Thunb.) Merr.	Cempedak	Fu	√		√	
		<i>Artocarpus altilis</i> (Parkinson)	Breadfruit	Fu	√			
13	Myrtaceae	<i>Psidium Guajava</i> L.	Guava	Fu	√	√	√	
14	Rubiaceae	<i>Coffea arabica</i> L.	Arabian coffee	Pla		√	√	√
15	Rutaceae	<i>Citrus maxima</i>	Pomelo	Fu		√		√
		<i>Citrus limon</i> (L.)	Lemon	Fu	√		√	√
		<i>Citrus reticulata</i> Blanco	Mandarin orange	Fu	√		√	√
16	Sapindaceae	<i>Pometia pinnata</i> J. R. Forst. & G. Forst.	Matoa	Fu	√			
		<i>Nephelium lapaecum</i> L.	Rambutan	Fu	√	√	√	√
		<i>Dimocarpus longan</i> Lour.	Longan	Fu	√			
17	Sapotaceae	<i>Manilkara zapota</i> (L.) P. royen	Sapodila	Fu	√	√	√	√
18	Solanaceae	<i>Solanum tuberosum</i> L.	Potato	Ve			√	

*Most preferred host

**Fu=fruit, Ve=vegetable, Me=medicinal plant, Wi=wild plant, Or=ornamental, We=weed, Pla=plantation crop

***Bo=Bogor, Su=Sukabumi, Pu=Purwakarta, Ga=Garut

The result of this study is similar to the research of [8], which found the mealybug *E. hispidus* on 12 fruit host plants, including star fruit, duku, durian, guava, mango, mangosteen, jackfruit, banana, rambutan, sapodilla, sugar apple and soursop respectively. [1] also reported that 14 plant species recorded as host including duku, rambutan, cocoa, jackfruit, sugar apple and coconut respectively. This study has not found a new host plant other than those previously reported.

The host plant of *E. hispidus* varies from fruit crops to weeds. The results of this study found 7 categories of plants recorded as host of *E. hispidus*, including fruit crop, ornamental, medicinal plant, weed, vegetable, plantation crop, and wild plant respectively. Mostly found in fruit plants 52%, ornamental 13%, wild plant 10%, plantation crop 6% and the least found in medicinal plants and weed 3% (figure 2). Mostly found in fruit because the sampling location is dominated by fruit plants. In Bogor, Sukabumi, and Purwakarta sampling was carried out around mangosteen plantations and in Garut by citrus plantations. In addition, most surveys were conducted during the fruit season. Farmers in the four locations usually plant fruit intercropping with other fruit crops. Intercrop planting will also increase the number of host plant for these pests, so that when the main fruit crop does not bear fruit, these pests can live on the intercrop plant.

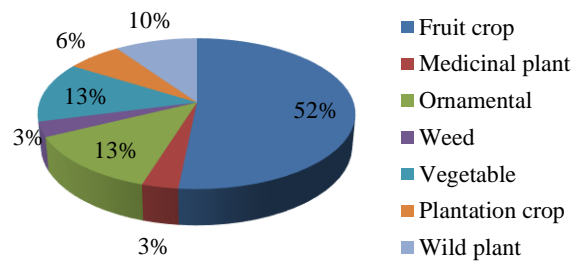


Figure 2. Host plant category associated with *E. hispidus*.

Table 2. Major host plant of *E. hispidus* in Bogor, Sukabumi, Purwakarta and Garut, West Java.

Study site	Major host plant						
	Cocoa	Duku	Lemon	Mangosteen	Rambutan	Sapodila	Soursop
Bogor	√	√	-	√	√	√	√
Sukabumi	√	√	√	√	√	√	√
Purwakarta	√	√	√	√	√	√	√
Garut	√	√	√	-	√	√	√

Among the 31 species of host plants, there were host plant that preferred by *E. hispidus*. In this preferred host plant, the population abundance was more. The host plant with an abundance of more than 30 adult females is considered as the most preferred host plant [6]. The results indicated that some fruit plants were the most preferred host plants including cocoa, duku, rambutan, sapodilla, lemon and mangosteen respectively. But the lemon was not the major host plant in Bogor and Mangosteen was not major host plant in Garut (table 2).

3.2. The part of the host plant that is inhabited by *E. hispidus*

Mealybugs can be found on all parts of the plant. Preferred parts of the plant were those protected from sunlight. In this study, mealybugs were found on all parts of the plant except the roots. The plant parts inhabited by *E. hispidus* were mostly fruit (22), followed by flower (11), leaf (8), shoot (5), and the least on the stem (3) (table 3). On the fruit, mealybugs inhabit many parts of the fruit including petals, grooved rind and fruit stalks. On flowers, mealybugs were found on the petals and flower stalks, while on the

leaves, mealybug found on the lower leaves. Mealybugs found on the stem was the lowest, presumably because the stem was hard enough to pierce with the stylet.

The mealybugs found on leave, twig, stem and fruit [8]. The most inhabited part is the lower leaves, while the least were the stem and shoots. *E hispidus* found on mangosteen fruit petals, mangosteen rind, and stigma [9]. Mealybugs on dragon fruit inhabit on the surface of the fruit near the areole or in the crevice [3].

Table 3. The part of the host plant that was inhabited by *E. hispidus*.

No	Family	Species	The part of the host plant that is inhabited				
			Stem	Shoot	Leaf	Flower	Fruit
1	Annonaceae	<i>Anona muricata</i> L.		√		√	√
		<i>Anona squamosa</i> L.		√		√	√
2	Arecaceae	<i>Areca catechu</i>				√	√
		<i>Dypsis lutescens</i> (H. Wendl.) Beentje & J. Dransf.			√		√
3	Asparagaceae	<i>Agave americana</i> L.			√	√	
4	Caesalpiniaceae	<i>Caesalpinia pulcherrima</i> (L.) Sw.				√	
5	Clusiaceae	<i>Garcinia mangostana</i> L.				√	√
6	Cucurbitaceae	<i>Sechium edule</i> (Jacq.) Swartz					√
7	Euphorbiaceae	<i>Macaranga triloba</i>				√	
8	Fabaceae	<i>Gliricidia sepium</i> Walp.				√	
		<i>Cajanus cajan</i> (L.) Millsp	√			√	√
9	Malvaceae	<i>Durio zibethinus</i> Murray					√
		<i>Hibiscus tiliaceus</i> L				√	
		<i>Hibiscus rosasinensis</i>				√	
		<i>Theobroma cacao</i> L.	√				√
10	Melastomataceae	<i>Melastoma malabathricum</i> L				√	
11	Meliaceae	<i>Lansium domesticum</i> Correa					√
12	Moraceae	<i>Artocarpus heterophyllus</i> Lam.					√
		<i>Artocarpus integer</i> (Thunb.) Merr.					√
		<i>Artocarpus altilis</i> (Parkinson) Fosberg					√
13	Myrtaceae	<i>Psidium Guajava</i> L.		√	√	√	√
14	Rubiaceae	<i>Coffea arabica</i> L					√
15	Rutaceae	<i>Citrus maxima</i>					√
		<i>Citrus X limon</i> (L.) Burm. f. (pro. sp.)					√
		<i>Citrus reticulata</i> Blanco					√
16	Sapindaceae	<i>Pometia pinnata</i> J. R. Forst. & G. Forst.					√
		<i>Nephelium lapaecum</i> L.					√
		<i>Dimocarpus longan</i> Lour.					√
17	Sapotaceae	<i>Manilkara zapota</i> (L.) P. royen		√	√	√	√
18	Solanaceae	<i>Solanum tuberosum</i> L.				√	

Various types of plants that become hosts include plants that have high economic value. Sirisena et al found 11 species belonging to seven genera were collected from 13 fruit crops Economically in Sri Lanka [10]. Mealybugs attack which causes the growth of sooty mould, which reduces the appearance and reduces the economic value of the fruit. Major host plants are fruit crop including duku, rambutan, sapodilla, soursop, mangosteen, lemon and one plantation crop cocoa. The fruit was the most inhabited by *E. hispidus* including 22 species. *E. hispidus* which is abundant in fruit can be carried over to the fruit harvest, and it's potential to become a quarantine pest of great concern. The mangosteen fruit is one of the major host plant, even though the mangosteen fruit is an Indonesian export commodity [11]. *E. hispidus* is included in the regulated pest list for mangosteen from Indonesia [12].

Mealybug control needs the serious attention of farmers. Mealybug pest control is less effective due to their habit of hiding in the crevices and the presence of waxy covering of its body [13]. Selection of the main crops and intercrops plant is also important. Farmers often plant intercropping plants that are hosts for mealybugs. Wild plant and weed can serve as an alternative host when the major host plant is not available. Integrated management with effective weed manipulation, crop rotation, and quarantine measures will be able to control these pests [6, 14].

4. Conclusion

Cocoa mealybug *E. hispidus* has a wide host range of over 31 host plants in 18 families. The host plants of *E. hispidus*, 52% were fruit trees, and 3% were medicinal plants and weeds. The major host plants were fruit crops including cocoa, duku, rambutan, sapodilla, soursop, mangosteen and lemon. The part of the plant which is inhabited by *E. hispidus* mostly is on the fruit and the least on the stem.

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