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Short Communication: Floral diversity of honey bee-collected pollen (*Apis cerana*) colonies in the Ir. H. Djuanda Forest Park, West Java, Indonesia

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Abstract. *Nuriyah S, Husodo T, Hermawan W, Yusuf AA, Kasmara H, Kusmoro J, Wulandari I, Shanida SS. 2021. Short Communication: Floral diversity of honey bee-collected pollen (*Apis cerana*) colonies in the Ir. H. Djuanda Forest Park, West Jawa, Indonesia. Nusantara Bioscience 13: 185-193.* Honey bees, especially *Apis cerana* Fabr., need feed sources from nectar and pollen. In addition, pollen is essential for sexual reproduction. However, various plants in the forest park have not been supported by information on pollinated plants or as feed sources by *A. cerana*. Therefore, this study should be conducted as essential information to reveal the pollens as feed sources of *A. cerana* in the Ir. H. Djuanda Forest Park, West Java. However, there is little information about those plants in the forest park, West Java. Therefore, this study aimed to reveal the pollens as feed sources of *A. cerana* in the Ir. H. Djuanda Forest Park. Sampling was collected on 45 honey bee-collected pollen from three cultivation areas. Pollen preparation was carried out using the acetolysis method. Based on the study results, 70 species of pollen flora of 36 families were found in Ir. H. Djuanda Forest Park vegetation in the *A. cerana*. However, further study is needed regarding the frequently visited plants used as feed sources or pollinating by *A. cerana*. In addition, considering that the honey bees cultivated in the forest park are dominated by *A. cerana*, further studies are needed on regularly pollinated plants to maximize the yield of honey cultivation.

Keywords: *Apis cerana*, Ir. H. Djuanda Forest Park, pollen

INTRODUCTION

Pollination is a vital ecological service provided by many insects, such as flies, wasps, bees, butterflies, beetles, and moths (Tumminelo et al. 2017). Pollination permits plant reproduction, which provides seeds, fruit, and leaves consumed by humans throughout the globe (Eeraerts et al. 2020). Without these services, it is feared that many interconnected processes in an ecosystem would collapse (Ollerton et al. 2011). Various pollination sources include insects, wind, air, rain, humans, animals, and birds (Delaplane et al. 2013). Insect pollinators are indispensable in pollinating food crops (Akhtar et al. 2018). Diptera, Hymenoptera, Lepidoptera, and Coleoptera can deliver an essential ecosystem service of pollination, which is vital for maintaining wild plants and crop communities (Noriega et al. 2018).

Asian honey bees, *Apis cerana* Fabr., are from southern and south-eastern Asia with various subspecies found in different Asian countries, including Indonesia (Hyatt 2012), e.g., *A. cerana javana*. *Apis cerana* is an excellent pollinator of many crops that improves quality and quantity (Pudasaini 2014; Pudasaini and Thapa 2014a). Similarly, *A. cerana* is an efficient pollinator compared to *A. mellifera* and *A. dorsata* in natural conditions (Pudasaini and Thapa 2014b). The pollination mechanism is formed from symbiotic interactions between flowering plants and animals (Gill et al. 2016). When plants receive pollination services, honey bees get energy and protein sources from nectar and pollen. Nectar is the source of carbohydrates, primarily energy, and pollen is the primary source of protein, fats, minerals, and vitamins (Nicolson 2011). Pollen and nectar are honey bee feed sources from flowering plants around their beehive to fulfill their daily needs (Keller et al. 2015). Pollen is a crucial component in pollination because, without pollen, the sexual reproduction of various flowering plants will not occur (Garibaldi et al. 2014). Therefore, maintaining honey bees is very useful for multiple flower pollination services, and it could get products such as honey, propolis, royal jelly, and bee wax (Sihag and Gupta 2011).

The knowledge of bees' biology and ecological behavior is essential in apiculture, which helps understand the associated problems and management (Aryal 2019). Also, the ability of honey bee nutrition is necessary to successfully manage issues that may occur in the apiary (Somerville 2005). The previous studies had been conducted in Indonesia. Yolanda et al. (2020) studied the diversity and character of pollen as *A. cerana* feed sources in Serang Purbalingga, Central Java. They sampled the honeycomb and fresh flowers around the honeycomb. Sudarmono (2019) studied pollen diversity from the fresh flower in the Bogor Botanical Garden, West Java. Salamah et al. (2019) only studied the pollen morphology of Asteraceae from a fresh flower in Depok, West Java. Mursyidin et al. (2018) only studied the pollen diversity of the *Oryza sativa* cultivars in the South Kalimantan. Widowati et al. (2013) and Widowati et al. (2020) studied the effect of pollen substitutes on the productivity of *A. cerana* in Bandung, West Java. Pollen substitutes can increase the productivity of *A. cerana*. Hidayati et al. (2020) studied pollen diversity in *Apis* spp. and stingless bee honey in Boyolali District, Central Java. Kviesis et al. (2020) studied temperature and weight monitoring of the *A. cerana* bee colony using the SAMS monitoring devices in the Madu Maribaya Apiary Ir. H. Djuanda Forest Park, West Java. They found that temperature and weight monitoring can be used for remote bee colony monitoring and is essential for reliable colony temperature collection. Nuriyah et al. (2021) studied about ecosystem services of *A. cerana* in the Ir. H. Djuanda Forest Park. They found 83 species of 39 families as feed sources of *A. cerana* in three honey bee cultivations. Thus, *A. cerana* provides ecosystem services to the sustainability of Ir. H. Djuanda Forest Park.

Those studies revealed pollen diversity of *A. cerana* from fresh pollen and or honeycomb. However, the study of pollen diversity from corbicular pollen is still lacking, so this study should be conducted to reveal the feed sources of *A. cerana*. It is essential to understand the plant diversity as pollen sources of *A. cerana* so that beekeepers can make appropriate and informed management decisions. Also, this study must be conducted as basic information and be the latest information about the pollens in West Java, Indonesia. According to the introduction, this study investigates the floral diversity of honey bee-collected pollens in managed *A. cerana* colonies in Ir. H. Djuanda Forest Park, West Java, Indonesia.

MATERIALS AND METHODS

Study area

Ir. H. Djuanda Forest Park is located 107° 30'00" E and 6° 52'00" S, approximately 7 km from downtown Bandung District, West Java, Indonesia. The Forest Park is located in Cikapundung Sub-watershed and the Citarum watershed, stretching from *Curug* (Waterfall) Dago, Dago Pakar, and *Curug* Maribaya. The detail of the study area can be seen in Figure 1.

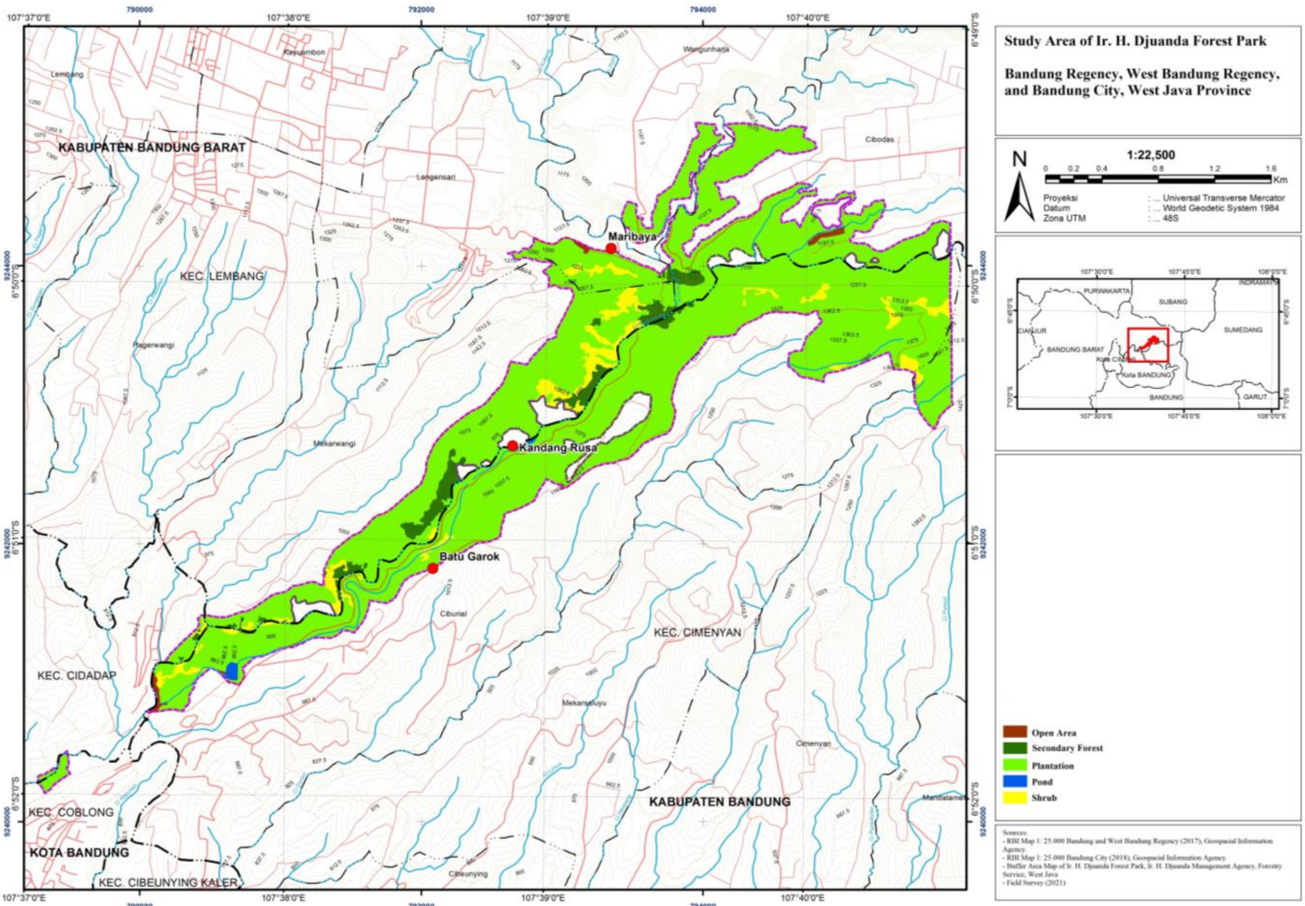

Figure 1. The study area in Batu Garok (6°51'24.55"S 107°37'44.93"E), Deer Captive Breeding (*Penangkaran Rusa*) (6°50'37.33"S 107°38'59.88"E), and Maribaya (6°50'7.25"S 107°39'30.23"E), Ir. H. Djuanda Forest Park, Bandung District, West Java, Indonesia

Administratively, Ir. H. Djuanda Forest Park is located in Ciburial Village, Cimenyan Sub-district, Bandung District, and parts of the area in Mekarwangi Village, Cibodas Village, Langensari Village, and Wangunharja Village, Lembang Sub-district, West Bandung District and Dago Village, Coblong Bandung Sub-district, Indonesia (Ir. H. Djuanda Forest Park Management Center 2019). Ir. H. Djuanda Forest Park has an area of 528,393 hectares with a land cover dominated by plantation forests of 475,158 hectares. Other land cover types are secondary forest covering an area of 19,652 hectares, shrubs covering an area of 29,558 hectares, ponds covering an area of 1,187 hectares, and open areas of 2,838 hectares.

Ir. H. Djuanda Forest Park is part of the Bandung basin area, with a historical background intimately related to ancient times (Ervinal et al. 2020). Ir. H. Djuanda Forest Park has become a protected area whose space is used for tourism activities. The Local Government also supports spatial utilization in the North Bandung area set out in the West Java Provincial Act No. 25 of 2008 about the Management of Ir. H. Djuanda Forest Park, that tourism is one of the activities in the protected area of North Bandung (Arief 2013).

Procedures

Hand-collection

The study was conducted in August 2021 in the three cultivation areas, including Maribaya, Batu Garok, and Deer Breeding (*Penangkaran Rusa*). Three colonies were selected for each cultivation area. The *A. cerana* used is an individual that carried pollen on the hind legs (corbiculae) compacted in the pollen sac. We took five honey bee-collected pollen per colony. Thus, the number of honey bees used in the sampling was 15 individuals in each cultivation area. A total of 45 individuals of *A. cerana* (from three cultivation areas) were sampled. Sampling was conducted by catching them with tweezers directly when they wanted to enter the hive. Each sample was put into separate papillote paper. We separated each sample (corbiculae) to avoid contamination.

Acetolysis method

Pollen identification is more accurate using the acetolysis method (Jones 2014). The acetolysis method is the standard method in palynological preparation. This method is also indispensable for illustrating pollen grains through light microscopy. Stained pollen grains will cover the visuals of the pollen grains, making it difficult to provide an overview of the pollen grains. The acetolysis process removes the cellular wall and the intine and destroys the aperture membrane. In addition, cleaning the surface of the pollen grain and coloring the pollen can make it easier for researchers to observe all the details of the pollen grain wall (Erdtman, 1960). The Acetolysis method is a combination method between chlorination and acetylation procedures (Hesse et al. 2009).

During the Chlorination stage, pollen was put into a centrifugation tube, added with 98% Glacial Acetic Acid (AAG), and 3-4 drops of HCl were then stirred using a glass rod to mix evenly. The pollen was heated using a water bath for three minutes. After heating, the pollen was centrifuged at 2,000-3,000 rpm for 10 minutes. Centrifugation served to precipitate pollen grains, making it easy to separate pollen grains from dirt when changing liquids (Sudarmono and Sahromi 2012). The supernatant was removed slowly for the pollen deposits were not wasted, and the residue was washed with distilled water. It was centrifuged again at 2,000-3,000 rpm for two minutes. Washing was carried out three times to remove AAG.

During Acetylation Stage, a mixture of 98% AAG and sulfuric acid in a ratio of 9:1 was dropped into the tube. After that, it was heated to 100°C for four minutes. The pollen was centrifuged at 2,000-3,000 rpm for 10 minutes. The supernatant was removed slowly for the pollen deposits were not wasted, and the residue was washed with distilled water. It was centrifuged again at 2000-3000 rpm for two minutes. Washing was done three times to remove the mixture of AAG and sulfuric acid.

After the acetolysis method, the pollen samples were stored in wet preservation. The sample was stored in a 20 cc vial and added to distilled water. According to Halbritter (2018), dry and fresh pollen must be hydrated with water to obtain a good quality pollen grain, ensuring that the pollen grains are not damaged or contaminated with fungi. Each vial was labeled with a label.

Then, the sample was stored in the refrigerator; if the samples were observed and identified, samples from wet preservation were taken as much as 1-2 drops on an object glass and added one drop of glycerin. According to Halbritter (2018), it should be observed as soon as possible after being given glycerin because the pollen grains will expand in a few days or weeks. Then, the sample was covered with a cover glass. Nail polish was applied to the edges of the cover glass to avoid shifting the cover glass. After that, the microscope slide was dried on a hotplate and labeled on the microscope slide on each sample. We use the guidelines to identify pollen, such as Erdtman (1969) and Faegri and Iversen (1989). The parameters in identifying pollen, namely family, species, and pollen form (pollen unit, pollen size category, pollen size (μm), and ornamentation type). Pollen measurement was carried out based on the size of the longest axis, which was divided into six sizes, namely very small: < 10 μm, small: 10-25 μm, medium: 25-50 μm, large: 50-100 μm, very large: 100-200 μm, and giant: > 200 μm.

Data analysis

The data were analyzed in Microsoft Excel and tabulated in the table. The results were described qualitatively.

RESULTS AND DISCUSSION

Based on the study results, 70 species of pollen from 36 families were found (Table 1). Some pictures of pollen grains found during the identification can be seen in Figure 2. Some plants in the Ir. H. Djuanda Forest Park are found in the corbiculae of *A. cerana*. Table 1 shows that some plants can be found in plantation forests, secondary forests, and shrubs in Ir. H. Juanda Forest Park. In general, the pollen identified was dominated by pollen units of monads, while the others were found in polyads and tetrads. Based on the size category, pollen ranged from very small to large.

Suwannapong et al. (2013) identified pollen from the *A. cerana* midgut recorded as many as 25 species in Northern Thailand. They found that the favored pollen source plant of *A. cerana* was *Mimosa pudica*. *Mimosa pudica* is widely distributed throughout the year and has a relatively high protein concentration in its pollen, so *M. pudica* becomes a favored feed source for *A. cerana*. Furthermore, the amount and diversity of pollen in honey are usually related to vegetation, climate, and geographical location of beehives. Therefore, the pollen composition of the honey studied reveals essential information on that region's flora (Cherian et al. 2011).

We assumed that the pollen flora in the corbiculae is plants that live 100 - 500 meters from nests (Hyat 2012). Still, their foraging ability will decrease if the desired feed is unavailable nearby. Pudasaini and Thapa (2014b) said that honey bees would approach the feed source habitat closer to the nest for energy effectiveness and efficiency. According to Partap and Yang (2012), the foraging behavior of honey bees leads to ecosystem services in plant pollination influenced by several factors, including nectar content, odor, color, and flower shape. Regarding foraging performance, the higher numbers of foraging trips of *A. cerana* than *A. mellifera* could be due to their shortage of foraging distance (He et al. 2013; Koetz 2013) or better learning and memory for color and grating patterns (Qin et al. 2012), or both. With more foraging trips, *A. cerana* will increase the amount of nectar brought into the colonies when all other conditions are equal. However, *A. mellifera* carries heavier nectar loads than *A. cerana* (Tan et al. 2012).

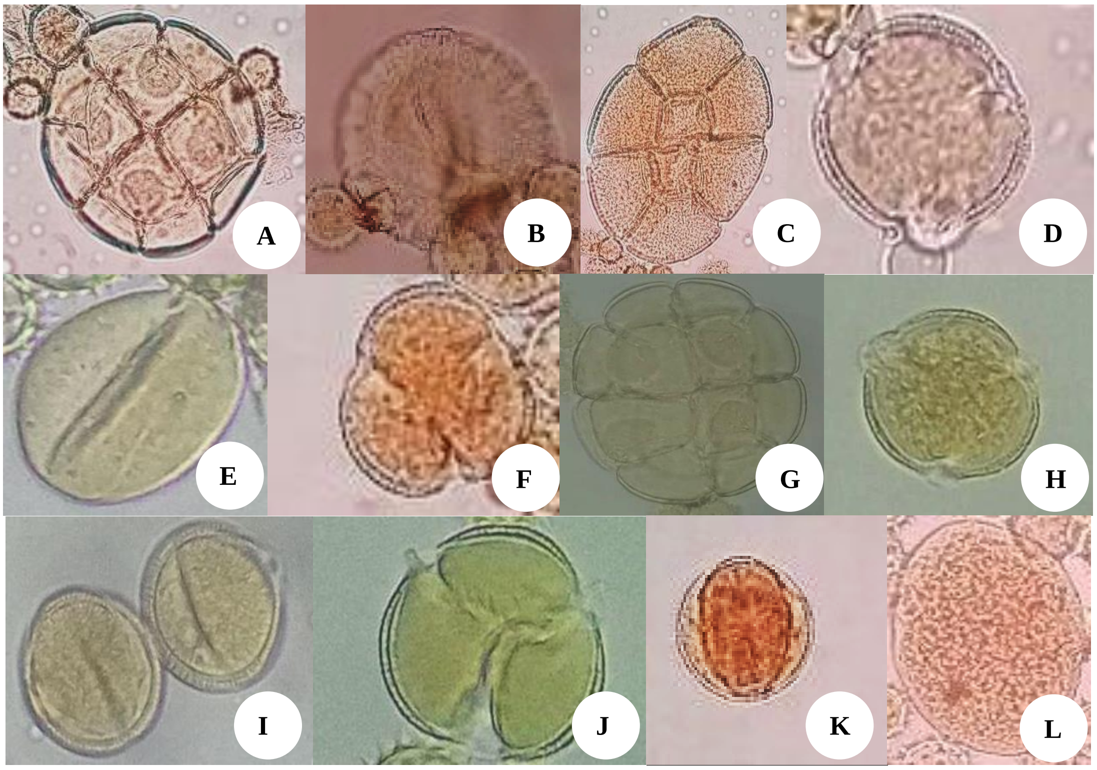

Figure 2. Some pollen grains were found during observation. A. *Acacia mangium* Willd., B. *Cinnamomum burmanni* (Nees & T.Nees) Blume, C. *Calliandra calothyrsus* Meisn., D. *Lantana camara* L., E. *Michelia champaca* L., F. *Calophyllum soulattri* Burm.f., G. *Cassia alata* L., H. *Capsicum frutescens* L., I. *Globa pendula* Roxb., J. *Saxifraga stolonifera* Curtis, K. *Castanopsis argentea* (Blume) A.DC., L. *Plantago major* L. (Primary Data 2021)

Table 1. The pollens in the corbiculae of *Apis cerana*, Ir. H. Djuanda Forest Park, West Java, Indonesia

Family | Species	Local name	Pollen morphology			
		Unit	Size		Ornamentation
			Category	µm	
Acanthaceae					
Pachystachys lutea Nees	*Bunga lilin*	Monad	Large	51-100	Reticulate, Tricolporate
Anacardiaceae					
Mangifera indica L.	*Mangga*	Monad	Small	0.75-1.33	Reticulate, Monocolpate
Mangifera foetida Blume	*Mangga bacang*	Monad	Small	0.75-1.34	Reticulate
Arecaceae					
Arenga pinnata (Wurmb) Merr.	*Aren*	Monad	Medium	26-50	Sulcate
Asteraceae					
Helianthus annuus L.	*Bunga matahari*	Monad	Medium	26-50	Spheroidal, Tricolporate
Ageratum conyzoides L.	*Babadotan*	Monad	Small	10-25	Spheroidal, Tricolporate
Acmella paniculata (Wall. ex DC.)	*Jotang*	Monad	Medium	26-50	Spheroidal, Tricolporate
Bidens pilosa L.	*Ketul*	Monad	Small	10-25	Spheroidal, Tricolporate
Balsamiaceae					
Impatiens balsamina L.	*Pacar air*	Monad	Medium	26-50	Spheroidal, Tricolporate, Reticulate
Bignoniaceae					
Kigelia aethiopica Decne.	*Pohon Sosis*	Monad	Large	51-100	Spheroidal, Tricolpate, Reticulate
Jacaranda filicifolia D.Don	*Jakaranda ungu*	Monad	Medium	26-50	Shperoidal, Tricolporate
Brassicaceae					
Brassica juncea (L.) Czern.	*Sawi hijau*	Monad	Medium	26-50	Shperoidal, Tricolpate, Reticulate
Brassica oleracea L.	*Sawi putih*	Monad	Medium	26-30	Prolate, Tricolpate, Reticulate
Caesalpiniaceae					
Tamarindus indica L.	*Asam Jawa*	Monad	Large	90	Oblate-spheroidal, Striato-reticulate, Tricolporate
Caesalpinia pulcherrima (L.) Sw.	*Kembang merak*	Tetrad	Medium	26-50	Inarpertura, Tricolporate, Psilate
Calophyllaceae					
Calophyllum soulattri Burm.f.	*Bintangur/Sulatri*	Monad	Medium	26-50	Spheroidal, Tricolporate, Reticulate
Cannabaceae					
Trema amboinensis (Willd.) Blume	*Mengkiray*	Monad	Medium	26-50	Spheroidal, Stephanoarperturate
Convolvulaceae					
Ipomoea quamoclit L.	*Rincik bumi*	Monad	Large	>100	Spheroidal, Pantoporate, Radial Symmetry
Cucurbitaceae					
Cucumis sativus L.	*Mentimun*	Monad	Large	51-100	Oblate-spheroidal, Trizonoporate, Faintly reticulate
Ebenaceae					
Diospyros discolor Willd.	*Bisbul*	Monad	Medium	41-50	Tricolporate, Reticulate, Psilate
Euphorbiaceae					
Ricinus communis L.	*Jarak pagar*	Monad	Medium	26-50	Prolate-spheroidal, Tricolporate, Reticulate, Bilateral symmetry
Euphorbia pulcherrima Willd. Ex Klotzsch	*Bunga euphorbia*	Monad	Medium	26-50	Prolate-spheroidal, Tricolporate, Reticulate

Fabaceae					
Delonix regia (Bojer ex Hook.) Raf	*Flamboyan*	Monad	Large	51-100	Prolate-spheroidal, Tricolporate, Reticulate
Leucaena leucocephala (Lam.) de Wit	*Lamtoro*	Monad	Large	51-100	Spheroidal, Tricolporate,
Glycine max (L.) Merr.	*Kedelai*	Monad	Small	21-25	Spheroidal, Tricolporate, Psilate
Gliricidia sepium (Jacq.) Kunth	*Gamal*	Monad	Medium	26-50	Spheroidal, Tricolporate, Psilate
Erythrina subumbrans (Hassk.) Merr.	*Dadap*	Monad	Medium	26-50	Oblate, Tricolpate, Reticulate
Calliandra calothyrsus Meisn.	*Kaliandra merah*	Polyad	Very Large	>100	Sub-Oblate, Porate
Acacia mangium Willd.	*Akasia*	Polyad	Medium	42.93-44.99	Tetracolporate, Psilate
Albizia chinensis (Osbeck) Merr.	*Sengon/ Albasia*	Polyad	Large	51-100	Quadrangular, Inarperturate, Psilate
Cassia siamea Lam.	*Johar*	Polyad	Large	92,85	Oblate-spheroidal, Tricolporate
Albizia sp.	-	Polyad	Medium	26-50	Inaperturate, Psilate
Cassia alata L.	*Daun ketepeng Cina*	Polyad	Large	125	Sub-prolate, Tricalporate
Mimosa pudica L.	*Putri malu*	Tetrad	Very Small	<10	Oblate, inaperturate, Psilate
Fagaceae					
Castanopsis argentea (Blume) A.DC.	*Saninten*	Monad	Small	10-15	Prolate, Tricolporate, Psilate
Gnetaceae					
Gnetum gnemon L.	*Melinjo*	Monad	Small	10-25	Inarperturate, Microechinate
Lamiaceae					
Gmelina arborea Roxb. ex Sm.	*Jati putih*	Monad	Medium	26-50	Prolate-spheroidal, Tricolpate, Reticulate
Ocimum x citriodorum Vis.	*Kemangi*	Monad	Large	51-100	Hexacolpate, Reticulate, Radial symmetry
Lauraceae					
Persea americana Mill.	*Alpukat*	Monad	Medium	26-50	Spheroidal, Inarperturate, Microechinate
Cinnamomum parthenoxylon (Jack) Meisn.	*Ki Pedes/ Ki sereh*	Monad	Medium	26-50	Prolate-spheroidal, Inarperturate, Microechinate
Cinnamomum burmanni (Nees & T.Nees) Blume	*Kayu manis*	Monad	Medium	26-50	Prolate-spheroidal, Inarperturate, Microechinate
Lythraceae					
Lagerstroemia speciosa (L.) Pers.	*Bungur*	Monad	Medium	26-50	Tricolporate, Fossulate
Magnoliaceae					
Michelia champaca L.	*Manglid/ cempaka*	Monad	Large	51-100	Oblate, Sulcate, Scabrate
Malvaceae					
Hibiscus rosa-sinensis L.	*Bunga sepatu*	Monad	Large	100	Pantoporate, Radial Symetry
Sida rhombifolia L.	*Sidaguri*	Monad	Large	51-100	Pantoporate, Echinate, Radial symmetry
Urena lobata L.	*Pulutan*	Monad	Medium	35	Oblate, Panto porate
Ceiba pentandra (L.) Gaertn.	*Kapuk randu*	Monad	Large	60-80	Tricolpate, Reticulate
Salmalia malabarica (DC.) Schott & Endl.	*Dangdeur*	Monad	Large	51-100	Oblate, Tricolpate, Reticulate
Durio zibethinus L.	*Durian*	Monad	Large	68-69	Triporate, Spheroidal
Melastomataceae					
Melastoma malabathricum L.	*Harendong bulu*	Monad	Small	16-20	Prolate-spheroidal, Tricolporate, Radial symmetry
Muntingiaceae					
Muntingia calabura L.	*Kersen*	Monad	Small	10-25	Prolate-spheroidal, Tricolporate, Reticulate
Myrtaceae					
Syzygium aqueum (Burm.f.) Alston	*Jambu air*	Monad	Small	10-25	Tricolporate, Psilate
Phyllanthaceae					
Antidesma bunius (L.) Spreng	*Huni*	Monad	Small	18	Tricolporate

Pineaceae					
Pinus merkusii Jungh. & de Vriese	*Pinus*	Monad	Large	50-60	Reticulate, Vesiculate
Plantaginaceae					
Plantago major L.	*Daun sendok*	Monad	Small	10-25	Porate-spherodial, Pantopertura
Rubiaceae					
Coffea arabica L.	*Kopi arabika*	Monad	Medium	26-50	Oblate-spheroidal, Bilateral Symmetry, Tricolporate
Anthocephalus cadamba (Roxb.) Miq.	*Jabon*	Monad	Small	10-25	Sheroidal, Tricolporate
Rutaceae					
Murraya paniculata (L.) Jack	*Kamuning*	Monad	Medium	31-35	Tricolporate, Striate
Saxifragaceae					
Saxifraga stolonifera Curtis	*Kuping macan*	Monad	Small	10-25	Oblate, Tricolpate, Striate
Solanaceae					
Capsicum annuum L.	*Cabai besar*	Monad	Medium	26-50	Spheroidal porate, Tricolporate, Scabrate
Solanum lycopersicum L.	*Tomat*	Monad	Small	10-25	Spheroidal, Tricolporate, Psilate
Solanum melongena L.	*Terung ungu*	Monad	Small	10-25	Prolate-spheroidal, Psilate, Bilateral symmetry
Capsicum frutescens L.	*Cabai rawit*	Monad	Medium	26-51	Prolate-spheriodal, Tricolpate
Theaceae					
Camellia sinensis (L.) Kuntze	*Teh*	Monad	Medium	26-50	Triangular, Tricolporate, Verrucate
Schima wallichii (DC.) Korth.	*Puspa*	Monad	Medium	26-50	Prolate, Tricolporate, Reticulate
Typhaceae					
Typha angustifolia L.	*Lembang*	Tetrad	Medium	36-50	Spheroidal, Ulcerate, Reticulate
Urticaceae					
Laportea interrupta (L.) Chew	*Jelatang ayam*	Monad	Small	11-15	Spheroidal, Triporate, Granulate
Verbenaceae					
Lantana camara L.	*Tahi ayam*	Monad	Medium	41-50	Colporate-spheroidal, Tricolporate, Psilate
Zingiberaceae					
Zingiber inflexum Blume	*Jahe-jahean*	Monad	Large	51-100	Spheroidal, Inaperturate, Areolate
Globa pendula Roxb.	*Pedas kancil*	Monad	Large	51-100	Spheroidal, Inaperturate, Echinate

In conclusion, some plants in the Ir. H. Djuanda Forest Park vegetation are also found in the corbiculae of *A. cerana*. However, further study is needed regarding the frequently visited plants by *A. cerana* and plants used as feed sources or pollinating. It is essential to reveal how *A. cerana* meets pollen and nectar needs throughout the year in Djuanda Forest Park, given that the flowering period of each plant is different. In addition, considering that the honey bees cultivated in Djuanda Forest Park are dominated by *A. cerana*, further studies are needed on regularly pollinated plants to maximize the yield of honey cultivation. This follow-up study can be used as information in honey bee management. Beekeepers and managers of Djuanda Forest Park can conserve plants pollinated by *A. cerana* in Djuanda Forest Park.

We recommend nutritional analysis of pollens and longer-term studies, as this study only covers a month. In addition, the phenology of flowering plants of importance to honey bees is highly diverse spatially and temporally. Therefore, beekeepers need better support to understand the floral resources in their operational range and to provide advice on how to protect and increase the availability of these plants for bees. Also, the beekeepers should understand how to implement appropriate supplementary feeding and manage honey bees during dearth periods using data initiated through this study.

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