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Common Palm Civet as a Potential Seed Disperser of Important Plant Species in Java

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Abstract. Common Palm Civet (*Paradoxurus hermaphroditus* Pallas) is known as a potential seed disperser. Most of the swallowed seeds is still intact and retains good germination power. This species is tolerant to human activities and is likely to inhabit human-disturbed ecosystems. Its ecological role as disperser was reported frequently, but only a report describe this role in Java 50 yr ago. Considering it, revealing plant species that is likely be dispersed by this species is important to support natural restoration of a degraded ecosystem in Java, Indonesia. We conducted a study in 600 ha secondary forest patch in Pekalongan, Center Java, Indonesia, managed by PERHUTANI. The study aimed to identify plant species that benefits from Civets for dispersing its seeds. The forest is a habitat of the Civet and rich in plant species diversity. We employed field survey to collect Civet-like feces and identify feces and seeds contained as well. During 2 mo field survey (May 2015 to June 2015) we collected 107 feces. As visual recognition may lead to misidentification of the feces, we applied a DNA-based technique employing species-specific marker. This technique successfully assigned 73 of 107 collected feces belonging to the Civet. The morphological observation identified 11 seeds species swallowed by the Civet. The size of the seeds ranged from 0.1 cm to 3.0 cm length and 0.1 cm to 1.7 cm wide. This study revealed that the Civet facilitates dispersal of some important plant species, such as Sugar Palm (*Arenga pinnata* Merr.), Arabican Coffee (*Coffea Arabica* L.) and Ficus (*Ficus variegate* Blume).

Keywords: Diet, dispersal, Indonesia, plant, Viverridae.

INTRODUCTION

Common Palm Civet (*Paradoxurus hermaphroditus* Pallas) is known as a potential seed disperser. They eat fruits, swallows its seeds and defecates it anywhere. Most of the swallowed seeds is still intact and retains good germination power. This animal species is tolerant to human activities and is likely to inhabit human-disturbed ecosystems [1]. Its ecological role as disperser was reported frequently [2–4], but only a report described this role in Java, Indonesia, 50 yr ago [5].

Considering its role as seed disperser, revealing plant species that is likely be dispersed by the Civet is important to support natural restoration of a degraded ecosystem in Java. As many ecosystems of Java has been degraded, there is an increasing need of ecosystem restoration. Information on how plants and animals species colonize an ecosystem in Java is of importance. Revealing the agents of plant dispersal and colonization is a part that attracts interest researcher since a long time ago [5] and the information need to be updated as environmental continuously change.

The last study on seed dispersers in Java is 50 yr old ago and the study has much weakness in its methods. Meanwhile, Javan ecosystem has been changing rapidly; therefore, it is needed to update the study. Here, we report a study that aims to identify plant species that benefits from Civets for dispersing its seeds. This information is useful when we consider restoring ecosystem involving natural process.

MATERIALS AND METHODS

This study was conducted in a 600 ha secondary forest patch in Pekalongan, Center Java, Indonesia managed by PERHUTANI. The forest is a habitat of the Civet and rich in plant species diversity. Beneath the forest canopy, local people grow coffee as a source of their livelihood. The forest area was divided into 60 grids of 10 ha for field survey purpose. During 2 mo survey (May 2015 to June 2015), Civet-like feces was searched for by

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following tracks and creeks, particularly near fruit trees in the forest area. Seed presence was used as a clue for initial recognition of Civet-like feces in the field. Additionally, fruits that were likely eaten by Civet was collected. These fruits collection functioned as references when identifying the seeds. All Civet-like feces was preserved in ethanol absolute for diet analysis in the laboratory. As visual recognition may lead to misidentification defecator of the feces, a DNA-based identification technique employing species-specific marker [6] was applied to identify the species of the feces. This technique employed DNA isolation using QIAamp stool mini kit (Qiagen), DNA amplification involving species-specific primer and Kappa Fast 2G PCR Mastermix (Kappa Inc) and DNA separation in agarose electrophoresis. After feces identification, seeds contained in the feces was identified by visually comparing it with references. All seeds contained in feces was extracted and grouped based on similarity. The seeds then compared with reference seed collected from the field. After identification, length and width of each seed was measured.

RESULTS AND DISCUSSIONS

DNA-based identification technique successfully assigned 73 of 107 collected feces belonging to the Civet. Using this simple and cheap technique, we can identify defecator of the feces unambiguously. However, this technique applies only to feces that has remaining good DNA. Therefore, not all feces could not be involved in the analysis. It may reduce the sample size in the analysis. Lack of good quality of DNA present in the feces was most likely cause the unsuccessful identification. Some of the feces were old, wet or exposed to the sun when found. It may lead to DNA degradation [7]. We recommend to collect feces samples in the early morning to minimize sun exposure and conduct field survey during dry season to avoid wet feces.

From 13 groups of seed found the feces, we successfully identified species of 10 seeds but failed to identify three remaining seeds species swallowed by the Civet. As literature study showed ambiguous result, we assigned the remaining three seeds as unidentified 1, 2 and 3 (Table 1). Incomplete reference is responsible for this failure. Although we have maximized our effort to collect fruits and seeds in our study area, there is possibility that the seeds originated from other areas. This undiscovered diet items suggests collecting reference material as much as possible not only from study area but also surrounding areas, particularly when conducting field study in the tropic with incomprehensive biological data base.

The size of the seeds ranged from 0.1 cm to 3.0 cm length and 0.1 cm to 1.7 cm wide. *Arenga pinnata* Merr. and *Artocarpus elasticus* Reinw. were the two largest seed swallowed by the Civets (Table 1). This finding was similar with previous result reporting maximum size of swallowed seeds is 28.6 mm length and 20.3 mm wide [8]. It is likely that the size is the maximum capacity of the Civet in dispersing seeds. It implies, larger seeds will have less possibility to be dispersed naturally by animal because large herbivores occupy only limited area of the forest (pers.comm).

Seeds of both species were found in five out of 73 Civet feces, meanwhile *Coffea robusta* Froehn. seeds (its size was relative small; Table 1) was the most frequently found in the feces. Although this frequency of occurrence did not reveal food preference of the Civet, however it may raise question about correlation between size and frequency of occurrence of seed found in the feces. Our further analysis showed that there was an unlikely correlation between frequency of seed occurrence in the feces and seed size. We found weak and insignificant correlation between frequency of occurrence and seed length (Spearman rho test: $r = -0.08$; $p > 0.05$) and between frequency of occurrence and seed wide (Spearman rho test: $r = -0.2$; $p > 0.05$) as well. It means, there is another factor than seed size influencing how often seeds of plant species swallowed by the Civet. The factors may be fruit characters [5] and availability in the field. Fruit characters are most likely influence food preference by the Civet. Beside nutrition contents, taste, palatability and other characters commonly studied, number and size of seed of a fruit may be eaten by animal. Although it seems no correlation between fruit and seed characters of a fruit, however animal does not prefer *difficult-to-handle* diet items. They may avoid fruits with large size and number of seeds since it will need much time to handle and digest. Additionally, since the Civet is generalist species, they have wide tolerant when utilizing resources, including food items. Their diet items will likely be determined by abundance of the items in their habitat. Further study needed to reveal influence of those factors.

This study revealed that the Civet potentially facilitates dispersal of some important plant species beneficial for local people, such as Sugar Palm (*Arenga pinnata* Merr.), Robusta Coffee (*Coffea robusta* Froehn.) and Ficus (*Ficus annulata* Blume). *Arenga pinnata* Merr. is very important sugar palm. The palm yields sugar, provides variety products and benefits to local people. This tree is well known as multipurpose tree species [9], but has low dispersal ability [10]. Most likely, their dispersal was facilitated by the Civet [5, 10]. Our social survey also confirmed this information. People near forest acknowledged Civet role as a disperser of Palm Sugar [11]. The people left some quntity of Palm fruit in the tree to be eaten by Civet when harvesting. *Robusta coffee* is another important plant species in the forest. Local people grow this plant beneath forest canopy and harvest the coffee cherry once in a year. We found that seeds of this species were most frequently occurred in Civet feces. It may imply that the Civet has an important role to disperse this plant. The plant is widely distributed

across the forest, not only as plantation but also as a wild plant in remote areas [1]. It is unlikely that local people grow the *Coffee robusta* in such area. Facilitating dispersal of the two plant species is an ecological role of the Civet that has been acknowledged by people. Beside that, the Civet dispers also plant species that is less beneficial for the people, but important for forest ecosystems. *Ficus annulata* Blume and *Ficus variegata* Blume were also plant species that its seeds found in the Civet feces. *Ficus* is well known as a genus that provides food and resting site for many animal species. Its presence attracts many animal species [12], therefore both tree species are very important for supporting faunal biodiversity. Besides all plant species described before, the Civet also swallowed seed of *Areca* sp., *Calamus* sp., *Musa acuminate* Colla and *Maesopsis eminii* Engl. Although the ecological role of those plant species is less known, however, they are endemic species of Java that should be conserved.

This research provide evidence of ecological role of the Civet as seed dispersers of several plant species. This role is important particularly in Java where ecosystems restoration is highly required. Not many animal species is capable to dispers large fruit because of their intolerance trait to human. Based on our findings, it is recommended that the Civet population should be managed. Although their persistence in the wild may be not under threat, but their role as dispersers will be optimal if their population size and distribution are secured.

TABLE 1. Seeds swallowed by Common Palm Civet. *Arenga pinnata* Merr. and *Artocarpus elasticus* Reinw. were two largest seeds, meanwhile *Coffea robusta* Froehn. was the most frequent seed found in the feces.

No.	Species	Family	Size (cm)				Freq. of Occur
			Lengh		Wide		
			mean	SD	mean	SD	
1	*Arenga pinnata* Merr.	Arecaeae	2.58	0.50	1.70	0.28	0.07
2	*Artocarpus elasticus* Reinw	Moraceae	3.07	5.98	1.39	0.35	0.07
3	*Ficus annulata* Blume	Moraceae	0.48	0.08	0.44	0.09	0.04
4	*Coffea robusta* Froehn.	Rubiaceae	1.02	0.14	0.80	0.11	0.42
5	*Maesopsis eminii* Engl.	Rhomnaceae	2.21	0.20	1.04	0.10	0.01
6	*Areca* sp.	Arecaeae	1.21	0.05	0.84	0.01	0.01
7	*Areca* sp.	Arecaeae	1.20	0.21	0.75	0.23	0.10
8	*Musa acuminate* Colla	Musaceae	0.61	0.11	0.51	0.12	0.12
9	*Calamus* sp.	Arecaceae	1.65	0.11	0.62	0.01	0.01
10	*Ficus variegate* Blume	Moraceae	0.10	0.00	0.10	0.00	0.01
11	*Unidentified 1*	-	1.39	0.31	1.22	0.31	0.08
12	*Unidentified 2*	-	0.14	0.00	0.12	0.00	0.01
13	*Unidentified 3*	-	1.94	0.00	1.14	0.00	0.01

CONCLUSION

Common Palm Civet may function as a seed disperser in Javan ecosystem. This function is evidenced by 13 seed species found in their feces. This result confirms the previous indication on the role of the species reported 50 years ago. This findings suggest population management for sustaining their population and distribution so that their important role as seed dispersers can be secured.

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