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THE DIET OF YELLOW-VENTED BULBUL (*Pycnonotus goiavier*) IN OIL PALM AGRO-ECOSYSTEMS

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ABSTRACT

*The Yellow-vented Bulbul (*Pycnonotus goiavier*) is one of the most sighted birds in oil palm plantation. A study on their dietary habits was conducted at the Durafarm Oil Palm Plantation from February 2011 to May 2013 to determine the reason behind their abundance. In this study, 45 individuals of* P. goiavier *were dissected for stomach content analysis. Ivlev's electivity index (E) was used to measure the degree of food selection by* P. goiavier. *The results showed that this bird species mainly selected the Order Coleoptera (mostly pollinating weevil) (E= +0.97) and Homoptera (E= +0.87) as their main food sources in the oil palm plantation. This bird also selected Order Diptera (E= -0.30), Hemiptera (E= -0.43) and Hymenoptera (E= -0.92) as a prey based on their abundance. However, this species mainly avoided feeding on insects from Order Odonata, Orthoptera, Dictyoptera and Lepidoptera (E=-1.0 each) in oil palm plantation. There is a weak negative correlation found for the distribution of* P. goiavier *with the abundance of insects in oil palm plantation. Further investigation is needed on this bird species towards predating the oil palm pollinating weevil, since it could possibly affect the population density of the pollinating weevil and subsequently the oil palm fruit set.*

Keywords: diet, Yellow-vented Bulbul, oil palm, Coleoptera.

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INTRODUCTION

The Yellow-vented Bulbul (*Pycnonotus goiavier*) is the most common of all bulbuls and best-known garden bird in Malaysia (Davison and Chew, 2008). This common resident bird can be found in almost all habitats except the deep forest, starting from mangrove to secondary forest and from rural to urban areas (Wee, 2009). According to Tan and Ria (2001) the success of *P. goiavier* in almost all habitats is due to their diverse diet, consisting of both plants and animals. In terms of food selection, *P. goiavier* is considered a generalist where they feed on flowers, nectar, fruits, insects and even carrion (Ward, 1969; Fishpool; Tobias, 2005; Wells, 2007), foraging near ground level (Myers, 2009). *P. goiavier* in oil palm plantations at Bah Jambi and Bukit Maradja were reported to have parts of Lepidoptera,

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and Coleoptera (Curculionidae) and seeds in their gut content (Chenon and Susanto, 2006). Now, they have successful adapted themselves to become one of the most abundant birds in cultivated areas such as the oil palm plantation (Chenon and Susanto, 2006; Amit *et al.*, 2011; Azman *et al.*, 2011). This bird species was also reported to contribute as a pest control agent in the oil palm ecosystem (Chenon and Susanto, 2006). The pollinating weevil (*Elaeidobius kamerunicus*) was introduced into Malaysia to overcome the inconsistencies of oil palm pollination (Syed *et al.*, 1982). The introduction of this species increased pollination and fruit production from 20% to 30% (Syed, 1982; Basri *et al.*, 1983). Now, this seemingly exclusive diet of the bulbul towards the pollinating weevil raises a new concern to the oil palm planters; whether the abundance of this bird species contributes to the low fruit set, as reported by some oil palm plantations in peat areas.

The diet of birds has been studied through examination of regurgitated samples (presumably from the crop), stomach samples analysis and faecal samples (Chapman and Roseberg, 1991; Major, 1990). Theoretically, prey content in regurgitated samples should be easier to identify because the samples represent recent feeding and has not undergone much digestion. This would be followed by stomach samples which represent slightly older feeding and last faecal samples which represent undigested food. There are several methods to extract prey content in birds such as through stomach flushing method (Martin and Hockey, 1993; Chou *et al.*, 1998), non-lethal potassium antimony tartrate method (Zduniak, 2005; Asokan *et al.*, 2009), faecal analysis method (Rodway and Cooke, 2002; Parrish 1994), and dissection method (Chenon and Susanto, 2006). The method of inserting solution from oesophagus to the stomach using syringe through flexible plastic tube and then removing the tube slowly leading to the regurgitation of at least part of the stomach content is similar between stomach flushing method and potassium antimony tartrate method but different in terms of the solution used. Stomach flushing method (Martin and Hockey, 1993) used water or saline solution while the other method used potassium antimony tartrate (Zduniak, 2005). In this study, the gut contents were determined through dissecting method, to assess the diet of this bird, which are available in oil palm ecosystem (Chenon and Susanto, 2006).

Our knowledge of the diet of *P. goiavier* in oil palm plantation on peat is still inadequate. Available studies include the analysis of gut contents from the Yellow-vented Bulbul in Indonesian oil palm plantation (Chenon and Susanto, 2006) on mineral soils and some observations on the behaviour of *P. goiavier* (Wee, 2009). So far there is no detailed information on the diet of *P. goiavier* in oil palm plantations. The aim of this study is to determine the diet of *P. goiavier* in oil palm plantations on peat via dissection method.

MATERIALS AND METHODS

Location and Description of Study Site

Sampling was conducted 10 times between 2011 to 2013 at the Durafarm Oil Palm Plantation (DFM) (*Figure 1*), located in Block 88 (N 01°23.827′ E 111°24.845′), Betong, Sarawak. This plantation belongs to WTK Sdn Bhd with palms from 6 to 13 years old. It has an area of about 5022 ha and located approximately 35 km from Betong town. Adjacent

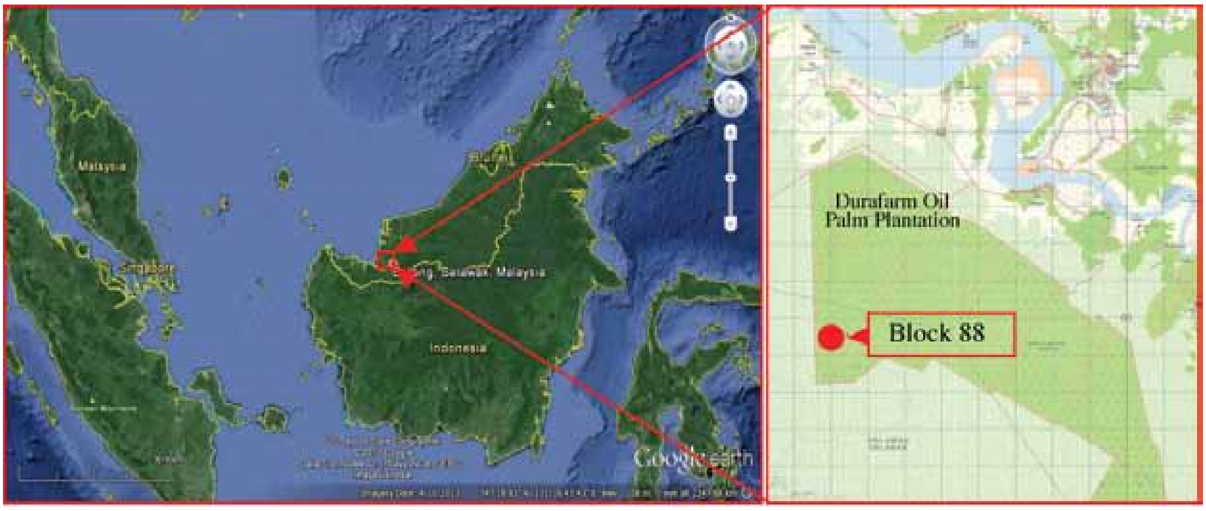

Figure 1. Map of the sampling site at the Durafarm Oil Palm Plantation, Block 88, Betong, Sarawak, Malaysia.

to this plantation is a peat swamp forest which was logged about 20 years ago and has been earmarked for oil palm development.

Field Method

Mist-net. In order to capture the bulbul, more than 10 mist-nets were set up at DFM. The nets were deployed in three rows with five nets per row. The nets were operated from 6.00 am until 6.00 pm for three days during each sampling periods and checked at every 2 hr interval (Rahman and Tuen, 2006). The captured Yellow-vented Bulbul (*Figure 2*) was placed in a cloth bag.

Figure 2. Yellow-vented Bubul captured in the Durafarm Oil Palm Plantation, Betong, Sarawak, Malaysia.

Out of 56 individuals recorded in this site, 45 individuals (80% of the total individual captured in DFM) were dissected for stomach content analysis and another 11 individuals were released back to DFM. The stomach of each bird was dissected open on site, washed and the contents rinsed into a vial containing 70% ethanol for laboratory analysis (Seefelt and Gillingham 2006; Durães and Marini, 2005). The samples were transported to a laboratory in the Universiti Malaysia Sarawak (UNIMAS), Sarawak, Malaysia for further analysis.

Distribution of food resources. A transect survey for insects and fruits was carried out by walking along the harvesting paths at Block 88, DFM. Three line transects (50 m length for each transect) were established at each row where the nets were set up. This survey was carried out during the same sampling day. All the insects and fruits available along transect were recorded. Identification for insects was done to the Order level only. Species of fruit found along the trail which cannot be identified on site were collected and brought to UNIMAS laboratory for further identification.

Laboratory Technique

Analysis of stomach content. The stomach contents were classified into insect parts and others such as plants, and arthropods. Identification of insect species present in the stomach was done by examining the samples under microscope and the prey items found inside the stomach were identified up to the Order level. The insect parts were identified based on Borror *et al.* (1954) and Triplehorn and Johnson (2005). The insect parts detected were head, mouthparts, elytra, mandibles, body structure, legs and wings. The insect parts were observed using a compound microscope with a camera attached. The images were taken by using Motic Image Plus Version 2.0 software with resolution of 1600 x 1200 pixels and the magnification lens were adjusted between the range of 2.0 – 7.5. The identified insect parts were sorted and recorded up to their respective Orders.

Statistical Analysis

Statistical analysis was carried out using statistical package for social sciences (SPSS-Version 17). Pearson's correlation coefficient (r) measures the closeness of the relationship between the abundance of insect per month and the distribution of Yellow-vented Bulbul per month in DFM. The value for a Pearson's can fall nearer to +1 or -1which shows the perfect relationship between the two variables.

Ivlev's Electivity Index

Ivlev's electivity index (E) was used to measure the degree of food selection by the Yellow-vented Bulbul in DFM towards a particular prey species. It is commonly used to compare the feeding habits of predator with the availability of potential food resources in the natural habitats (Strauss, 1979). The relationship is defined as:

$$E = \frac{r_i - p_t}{r_i + p_t},$$

where,

E = measure of electivity;

r_i = relative abundance of prey item *i* in the gut (as a proportion or percentage of the total gut contents); and

p_t = relative abundance of the same prey item in the environment.

The possible range of the index is - 1 to + 1. The negative value indicates avoidance or inaccessibility of the prey item, zero indicates random selection from the environment and positive values indicate active selection (Strauss, 1979).

RESULTS AND DISCUSSION

Availability of Food Resources (insects and plants) in Oil Palm Plantation

Agricultural ecosystem such as oil palm plantation provides a source of food to many birds in the form of grain, seeds, insects and rodents (Asokan *et al.,* 2009). Insects are one of the major preys consumed by birds in oil palm plantation (Chenon and Susanto, 2006; Koh and Wilcove, 2007). However, there is limited information on the diversity of insects in oil palm plantation in relation to bird diversity. Turner *et al.* (2008) and Turner and Foster (2009) have reported on the impact of conversion of forest to oil palm plantations on inverterbrate biodiversity.

In this study, the distribution of food resources (insects and fruits) in DFM was carried out by walking along the line transect where the mist-nets was set up. The results showed that a total of 687 individuals from nine Orders of insects were recorded for 10 times of sampling (*Figure 3*). The Order Hymenoptera (60.67%) especially from the family Formicidae was most abundant, followed by the Orders Diptera (13.50%), Odonata (9.00%) and Hemiptera (6.17%). The abundance of Hymenopterans from the family Formicidae in oil palm plantation supported the findings by Turner and Foster (2009) and Bawa *et al.* (2011). Family Formicidae is very important to the oil palm ecosystem, aiding in decomposition, pollination and preying on other pests besides acting as food sources for predators such as birds (Turner and Foster, 2009). The Order Homoptera was the least abundant insect Order in DFM plantation.

In terms of fruit survey, *Melastoma* sp. was the only fruit plant species recorded at the study site besides oil palm fruitlet. In plantation management, this noxious weed (*Melastoma* sp.) has to be controlled due to competition with the oil palm for nutrient, moisture and light (Barnes and Luz, 1990). Plant diversity in oil palm plantation is restricted to several adaptable natural ground cover or local vegetation such as ground and epiphytic ferns (Koh, 2008).

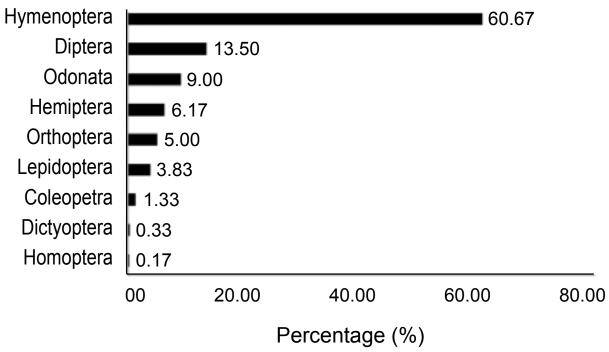

Figure 3. Percentage of individuals of each order of insect recorded in the Durafarm Oil Palm Plantation (DFM) for 10X sampling through line transect survey.

Distribution of *P. goiavier* in DFM

A total of 56 individuals of *P. goiavier* were captured in DFM through mist-netting methods. The distribution of this bird in DFM throughout the study period is shown in *Figure 4*. In this study, the Yellow-vented Bulbul was abundant in February. This is due to the breeding season for this bird, being early in the year between January to March (Myers, 2009), and they actively go out to search for food to feed the nestlings. However, in November, lesser number of this species was captured due to the rainy season at the end of the year. The capture rates of birds decreased during the rainy day because the birds seldom forage for food during the rain (Tuen *et al*., 2006; Gouk, 2009). The presence of insect in oil palm plantation play an important role to support the survival of birds that prey on insects (Chenon and Susanto, 2006; Koh and Wilcove, 2008). In this study, there is a weak negative relationship between the distribution of Yellow-vented Bulbul and abundance of insect in oil palm environment (r= -0.218). This value indicates that as the number of Yellow-vented Bulbul increases, the number of insect in oil palm environment decreases.

Yellow-vented Bulbul and its Diet in Oil Palm Plantation

In the study on the dietary of birds, there are some factors that should be included in our explanation such as foraging height, use of plant species, habitat selection and competition (MacArthur, 1958; Morse, 1968; Perrins and Birkhead, 1983). Hence, the presence of prey items in the stomach and availability of insect diversity in the environment can be used to determine the diet selection of birds at different habitats.

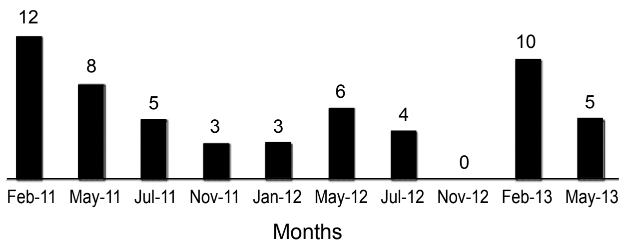

Figure 4. Total individuals of P. goiavier *in the Durafarm Oil Palm Plantation (DFM) at different months and years.*

A total of 45 individuals (80% of the total individuals of *P. goiavier* recorded in DFM) of *P. goiavier* were dissected to extract their stomach samples. The insect parts found in the stomach were grouped according to the Orders. *Table 1* shows the number of species and individuals of plant, annelids and insects according to different Orders and families found in the stomach of Yellow-vented Bulbul at DFM. Some insect parts that had been digested and could not be identified were recorded as unidentified parts. Examination of stomach content of *P. goiavier* showed that they feed on insects as well as on annelids, small berries, leaflets and oil palm fruitlets (*Figures 5, 6* and *7*).

The Ivlev's electivity index was used to measure the degree of selection by the predator towards a particular prey species. *Table 2* showed the Ivlev's electivity index for different insect Orders by Yellow-vented Bulbul.

The results showed that the Orders Coleoptera (E= +0.97) and Homoptera (E= +0.87) were mainly selected as prey items by *P. goiavier* and this result reflected that these Orders as the main food sources for this adaptable species in oil palm plantation. This bird seems to exclusively select as their food from the Coleopteran family Curculionidae (the pollinating weevil, *Elaeidobius kamerunicus*). This finding is similar to that of Chenon and Susanto (2006) who conducted their study at Bah Jambi and Bukit Maradja, Indonesia. *Elaeidobius kamerunicus* is one of the most important weevils in oil palm plantation. This species play an important role to increased pollination and fruit production from 20% to 30% (Syed, 1982; Basri *et al.*, 1983). Other Coleopterans

TABLE 1. NUMBER OF SPECIES AND INDIVIDUALS OF PLANT, ANNELIDS AND INSECTS FOUND IN THE GUT OF YELLOW-VENTED BULBUL

	Order	Family	Number of species	Number of individual
Plant species	-	-	8	11
Annelids	Haplotaxida	-	2	2
Insects	Diptera	Culidae	3	3
	Hemiptera	Unidentified	1	1
	Hymenoptera	Formicidae	1	1
	Homoptera	Cicadellidae	1	2
	Coleoptera	Staphylinidae	1	1
	-	Scolytidae	1	1
	-	Curculionidae	1	30
	Unidentified	-	1	1

TABLE 2. IVLEV'S ELECTIVITY INDEX OF DIFFERENT ORDERS

No.	Order of insect	Relative abundance of prey item in the gut, *ri*	Relative abundance of the same prey item in the environment, *pi*	Measure of electivity, E
1	Coleoptera	85.37	1.33	+0.97
2	Homoptera	2.44	0.17	+0.87
3	Diptera	7.32	13.50	-0.30
4	Hemiptera	2.44	6.17	-0.43
5	Hymenoptera	2.44	60.70	-0.92
6	Odonata	0.00	9.00	-1
7	Orthoptera	0.00	5.00	-1
8	Dictyoptera	0.00	0.33	-1
9	Lepidoptera	0.00	3.83	-1

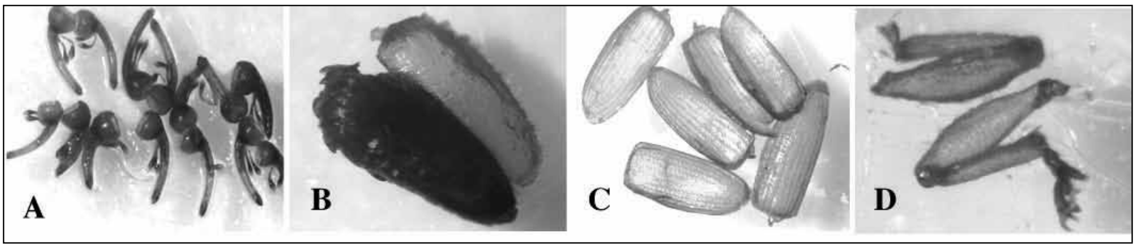

Figure 5. Elaeidobius kamerunicus *parts found in* P. goiavier*: (A) rostrum and antenna, (B) body, (C) elytra and (D) legs.*

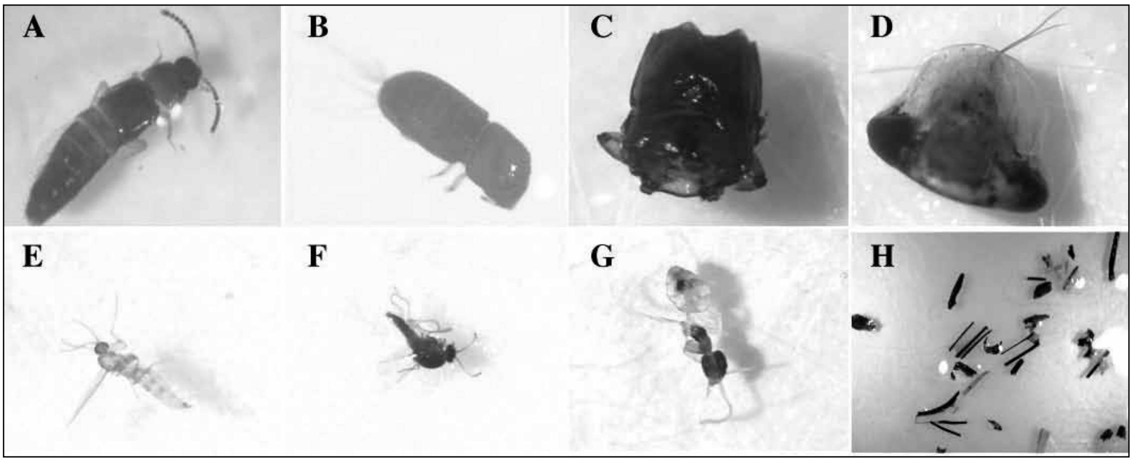

Figure 6. Some of the insect parts found in P. goiavier *gut: (A) Order Coleoptera; family Staphylinidae, (B) Order Coleoptera; family Scolytidae, (C) Order Homoptera; body part, (D) Order Homoptera; mouth part, (E) Order Diptera; family Culicidae, (F) Order Diptera; family Culicidae, (G) Order Hymenoptera; family Formicidae, and (H) Order Hemiptera; hind wings.*

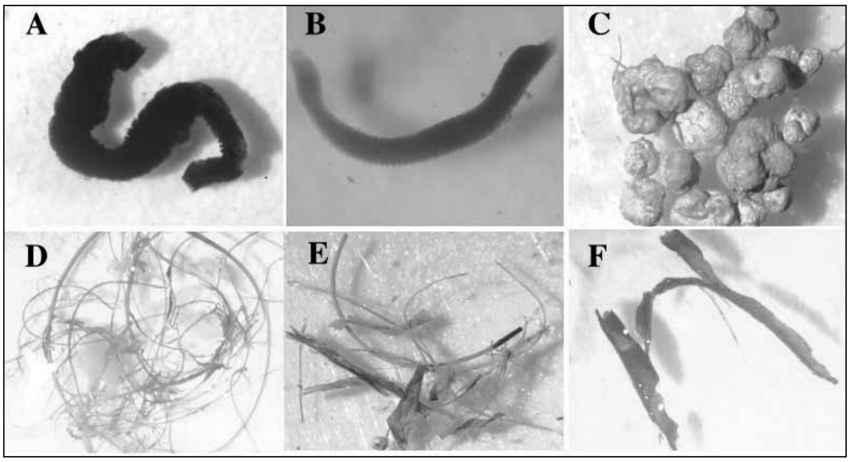

Figure 7. Other samples found in P. goiavier *gut: (A) class annelids; earthworm, (B) order annelids, (C) small berries, (D) oil palm fibres, (E) oil palm fibres and grass, and (F) grass part.*

consumed by this bulbul are the bark beetles (Scolytidae) and rove beetles (Staphylinidae) with 2.2% each from the total Order Coleoptera recorded in their gut. Other Orders such as Hemiptera (E= -0.43) and Diptera (E= -0.30) was selected by *P. goiavier* as prey based on abundance. *P. goiavier* tries to avoid preying on the Order Hymenoptera (E= -0.92) in the oil palm environment. This bird also avoids the Orders Odonata, Orthoptera, Dictyoptera and Lepidoptera. These Orders were present in the DFM but were absent in the birds gut.

This bird also feeds on oil palm fruitlets as revealed by the presence of some palm fruit fibres in stomach content; and this was not reported by Chenon and Susanto (2006). In terms of fruit survey along the line transect in oil palm plantation, *Melastoma* sp. was the only species of plant that was recorded to produce fruit besides oil palm. A total of eight individuals of this bird fed on unidentified plant species in oil palm plantation. This result shows that *Melastoma* sp. is not the only fruiting plant in the oil palm plantation because there were other unidentified berries recorded in their stomach content.

CONCLUSION

In an oil palm habitat, *P. goiavier* mainly select the Order Coleoptera (specifically from family Curculionidae, Staphylinidae, and Scolytidae) as their prey, followed by Homoptera (Cicadellidae), Diptera (Culidae), Hemiptera and Hymenoptera (Formicidae). This species avoids feeding on insects from the Order Odonata, Orthoptera, Dictyoptera and Lepidoptera. Even though the oil palm habitat is providing food sources for this bird species to continue their survival, further study is needed on the effect of this bird population on oil palm pollinating weevil and seasonal variation in their diet.

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