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Response of bird community to oil palm plantation and agroforestry in Dramaga campus IPB University, West Java, Indonesia

Syahras Fathin Aminuddin*[1], Lintang Yodhy[1], Heri Setiawan Yunus[1], Moh. Reza Sese[1], M. Dhiya'ur Rachman[1], Rizki Amaliah[1], Puji Rianti[2], Windra Priawandiputra[2], and Tri Atmowidi[2]

[1]Biosains Hewan, Departemen Biologi, Fakultas Matematika dan Ilmu Pengetahuan, Institut Pertanian Bogor, Bogor 16153, Indonesia
[2]Departemen Biologi, Fakultas Matematika dan Ilmu Pengetahuan, Institut Pertanian Bogor, Bogor 16153, Indonesia
*Corresponding author: yayasfathin19@gmail.com

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ABSTRACT

As oil palm plantations continue to grow and become a mainstay commodity in Indonesia, unfortunately, this also has an environmental impact that can threaten bird communities. On the other hand, the agroforest system is considered to be able to preserve the richness of bird species compared to other monoculture plantations. This study analyzes how bird communities' response in oil palm plantation and agroforestry habitats is compared based on diversity, composition, species similarity, feeding guilds, and bird space use. This study was conducted at the Kebun Pendidikan Cikabayan (KPC) in the oil palm plantation area and the Taman Hutan Kampus (THK) in the IPB Dramaga campus agroforestry area, using transect, count point and vantage point methods from September to October 2023. A total of 42 species belonging to 28 families were dominated by forest generalists, followed by open habitat generalists, forest specialists, and forest edge species, 50% of which were insectivores. The daily activities of the dominant species in both locations showed differences between the use of space in THK and KCP. Based on the diversity and evenness values, the THK location (H'= 2.95; E= 0.85) has a higher value than KPC (H'= 2.62; E= 0.78), although it is still in the same diversity category, namely moderate (H'= 2.5-2.9 in the moderate category). The species similarity index value also shows a species similarity of 75% between the two locations. Due to its relatively high diversity and potential carrying capacity for forest-dependent species in forest-agricultural landscapes, this area needs to be preserved and its habitat quality improved planting native tree species with tall, hard stems that are favored by hollow-nesting birds and food trees such as *Ficus* spp.

Key words: Bird community, IPB Dramaga, oil palm agroforestry

INTRODUCTION

In Indonesia, oil palm plantations (*Elaeis guineensis*) have experienced the most significant land expansion from the early 1990s until now compared to other commodities such as rubber and coffee plantations. In 2022, the estimated area of oil palm plantations in Indonesia is 15.34 million hectares, which can produce 46.82 million tons of CPO (BPS 2023). Oil palm plantations are not only expanding in Southeast Asia but also in Africa and South America, especially Brazil (Butler & Lurance, 2009; Wilcove & Koh, 2010). Oil palm plantations have spread widely in tropical Southeast Asia and are of serious concern because of their impact on biodiversity, especially on bird communities (Azhar et al., 2011).

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Several factors influence the biodiversity and structure of bird communities in oil palm plantations. Differences in the age characteristics of oil palm stands are considered one factor that can potentially influence the presence of bird species in oil palm plantations (Karuniyanti & Santosa, 2019). On the contrary, other studies (Teuscher et al., 2015) concluded that bird diversity and abundance depend on increased tree species in oil palm plantations. In addition, the most important predictors of bird species richness in oil palm plantations are the percentage of forest cover around the plantation (Koh, 2008) and the presence of shrubs that are allowed to grow underneath (Aratrakron et al., 2006).

On the other hand, the agroforestry system is considered capable of protecting the richness of bird species than other monoculture plantations (Suroso et al., 2023) due to the complexity of the vegetation that composes it (Hakim et al., 2021). Several bird species endemic to Java, most of which are classified as forest specialists and forest-edge specialists, are considered capable of adapting to the conditions of the agroforest system applied in West Java. (Muhamad et al., 2013). Land cover in the form of remaining forests or secondary forests around oil palm plantations also affects the diversity of bird species that live and use oil palm plantations (Ramlah et al., 2021).

The composition of bird communities can reflect how birds respond to their environment (Zurita & Bellocq, 2010). Bird community groups in oil palm plantations are considered to be more functionally limited in relation to diet and foraging strata (Almeida et al., 2016), with significant effects on certain bird feeding groups, such as frugivores, insectivores, and seed eaters (Yahya et al., 2022). The presence of generalists and specialist groups can also describe environmental conditions (Gregory & van Strien, 2010). On the other hand, through empirical approaches such as bird activity and behavior, we can also find out the response of birds to their environment (Herwono et al., 2011), considering the studies on birds' daily activities in oil palm plantations are still rarely studied (Azman et al., 2011; Azhar et al., 2013; Santosa & Sugiharti, 2018; Santosa et al., 2018; Ramlah et al., 2021).

The oil palm plantation sampling location is on the Bogor Agricultural University (IPB) campus, in the Ciampea-Dramaga landscape, which faces high urbanization pressure but also supports important bird conservation habitat, as indicated by increased species richness (Nugroho et al., 2021). A significant increase in the organization's area occurred in the Dramaga and Ciomas sub-districts between 2017 and 2022. However, land cover in Dramaga sub-district is still dominated by community plantation forests (Putri et al., 2024). Furthermore, studies of habitat gradients in the Ciampea-Dramaga landscape indicate heterogeneity in land cover and

variation in vegetation indicators between habitat types, which indirectly illustrates the complexity of vegetation structure at the landscape scale that supports bird communities (Nugroho et al., 2026).

Based on the description above, to find out more about the response of bird communities in oil palm plantations and agroforestry, we carried out an analysis of diversity, composition, and feeding guilds differing between oil palm plantations and agroforestry adjacent to each other, identifying bird species that are limited to oil palm plantations, and conversely identify bird species that are widespread in all habitats. Then, to analyze the use of space for birds against the presence of oil palm plantations and agroforestry, we will also analyze their daily activities. The study is located at the Kebun Pendidikan Cikabayan and Taman Hutan Kampus, IPB Dramaga Campus, Bogor.

MATERIALS AND METHODS

Location

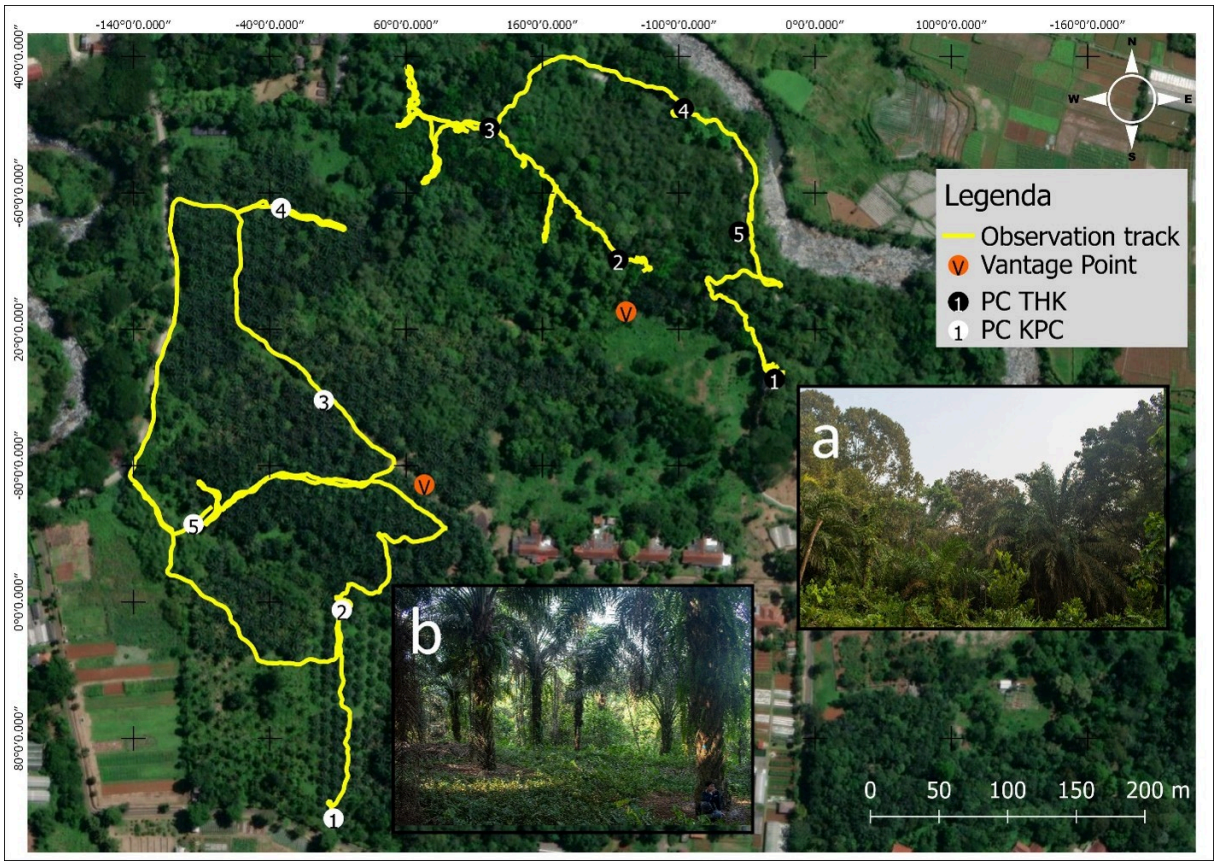

Figure 1. Map of sampling locations (black circle: THK Point Count with five collection points; white circle: KPC with five collection points; red circle: Vantage Point with one point in each habitat). (a) agroforestry in THK and (b) oil palm plantation in KPC

This research was conducted in two locations within the IPB University Dramaga campus area., oil palm plantations in Kebun Pendidikan Cikabayan (KPC) (6°33'07"S, 106°43'02"E, 170 meters above sea level) and agroforestry habitats in Taman Hutan Kampus (THK) (6°32'57"S, 106°43'10"E, 151 masl) (Fig. 1). KPC has an area of ±22 ha and only has one plantation species, oil palm (*Elaeis guineensis*). Meanwhile, THK has an area of 20 ha and is included in the agroforestry habitat type (Amri, 2023) which is recorded as having around 33 species of plants, with the dominant species including Meranti (*Shorea* spp.), Broadleaf Mahogany (*Swietenia macrophylla*) (Mustari, 2020), Cempaka (*Mangifera champaca*), Pine (*Pinus merkusii*), and Mahogany (*Swietenia mahagoni*) (Nabila et al., 2023). There are also dominant grass bushes, namely Mindi (*Melia azedarach*) (Mustari, 2020). The highest average rainfall between 2020 and 2022 occurred in October, 462.03 mm, and the lowest average rainfall occurred in July, 179.13 mm.

Data Collection

Bird observations were carried out from September to October 2023, with the point count method is used in conjunction with the transect method across all habitat types (Bibby et al., 2000). Species data were collected at five observation points along the transect route (1000 m) at each location with a distance between points of 150 m. Each point was carried out for 15 minutes with an observation radius of approximately 25 m. Every bird seen and heard within the observation radius is recorded. The transect method was carried out in the morning (07.00 to 10.00 AM) and in the afternoon (3.00 to 5.00 PM) by walking at a speed of 2 km/hour and recording all species of birds and the number of individuals.

To see whether there are differences in bird activity between KPC and THK we used the Vantage points method, which make it easier to observe bird, especially when flying above the canopy in a habitat, such as wetland areas, river banks, or bamboo groves (Sutherland et al., 2004). This research used vantage points to observe all bird activity that was heard and seen, from perching to flying back in THK. Bird activity was observed using the ad-libitum sampling method in the morning (07.00 to 10.00 AM) and afternoon (3.00 to 5.00 PM). Each bird activity will be categorized as preening, perching, feeding, vocalisation, walking and flying, which is carried out. The bird activity duration is calculated from when an activity starts until it changes activity. Repetition was carried out four times on each transect and vantage points to increase data accuracy.

Data Analysis

All birds have been identified based on Taufiqurrahman et al. (2022), Eaton et al. (2022) and arranged based on HBW (2023). The analysis will be calculated using Shannon's diversity index (H') to analyze species diversity (Magurran, 1998).; The evenness index was analyzed using the Pielou Evenness Index with the formula:

$$E = H' / \text{Ln } S \text{ (Ludwig \& Reynolds 1988)}$$

The dominance index (Di) is used to assess the dominant bird species in each location and is calculated using the formula:

$$Di = (Ni/N) \times 100\% \text{ (Van Helvoort, 1981)}$$

Ni is the number of individuals per species; and N is the total number.; Di value = 0 – 2% is a non-dominant species, Di = 2 – 5 % subdominant species,; and Di = >5% dominant species. The similarity value of bird species in each location is used to calculate the species similarity index with the formula

$$S = 2C/(A+B) \text{ (Sorenson, 1948)}$$

Where S is the similarity index, A is the number of species found in community A, B is the number of species found in community B, and C is the number of species found in both communities. We classified all species into forest specialists, forest-edge species, forest generalists, and open-habitat generalists based on direct observation and literature (Muhamad et al., 2013). Grouping guild categories including carnivores, frugivores, granivores, nectarivores, insectivores, and omnivores (Mackinnon et al., 2010) because the number of insectivorous bird species was much higher than that of another feeding guild, we further classified based on categorized into 11 feeding guild categories: birds that eat fruit in the tree canopy (AF), insect eaters that forage on tree branches or twigs (BGI), insect eaters, and fish or other vertebrates. (CI), fruit-eaters on the forest floor (IF), insect-eaters and nectar-eaters (IN), insect-eaters that search for food in the litter or forest floor (LGI), seed-eaters (SE), insect-eaters that search for feeding in bush areas (SFGI), eating fruit on the forest floor (TF), insectivores that spend their flying activities in the air (AI), and insectivores that actively forage in the tree canopy (TFGI) refers to Novarino (2008) and Rumblat et al. (2016). Analysis of the percentage of bird activity against the dominant species found in THK and KPC, (*Pycnonotus aurigaster*, *Spilopelia chinensis*, and *Orthotomus sepium*) using the behavior percentage formula from Altmann (1974).

RESULTS

Bird Community

A total of 42 bird species from 11 orders and 28 families were recorded during 300 hours of fieldwork. KPC had 32 species of birds from 10 orders and 19 families, and THK had 37 species from 11 orders and 23 families, while Passeriformes and cuculiformes are the most common bird species found in all locations. The most dominant species from point count in THK and KPC is *Pycnonotus aurigaster*, with a dominance ratio of 18.9% in THK and 30.8% in KPC. Based on the feeding guild, insectivores forage on tree branches or twigs (BGI), insectivores, and fish or other vertebrates. (CI), frugivores on the forest floor (IF) are the guild with the largest number of species in THK location, with each guild consisting of 7 species. In addition, in the THK location, no guilds of insectivores that forage in litter or forest floor (LGI) and eat fruits on the forest floor (TF) were found. Meanwhile, in the KPC location, all categories of feeding guilds were observed, including seed-eaters (SE) and insect eaters that forage on tree branches or twigs (BGI), with the largest number of species in each guild, consisting of 5 species.

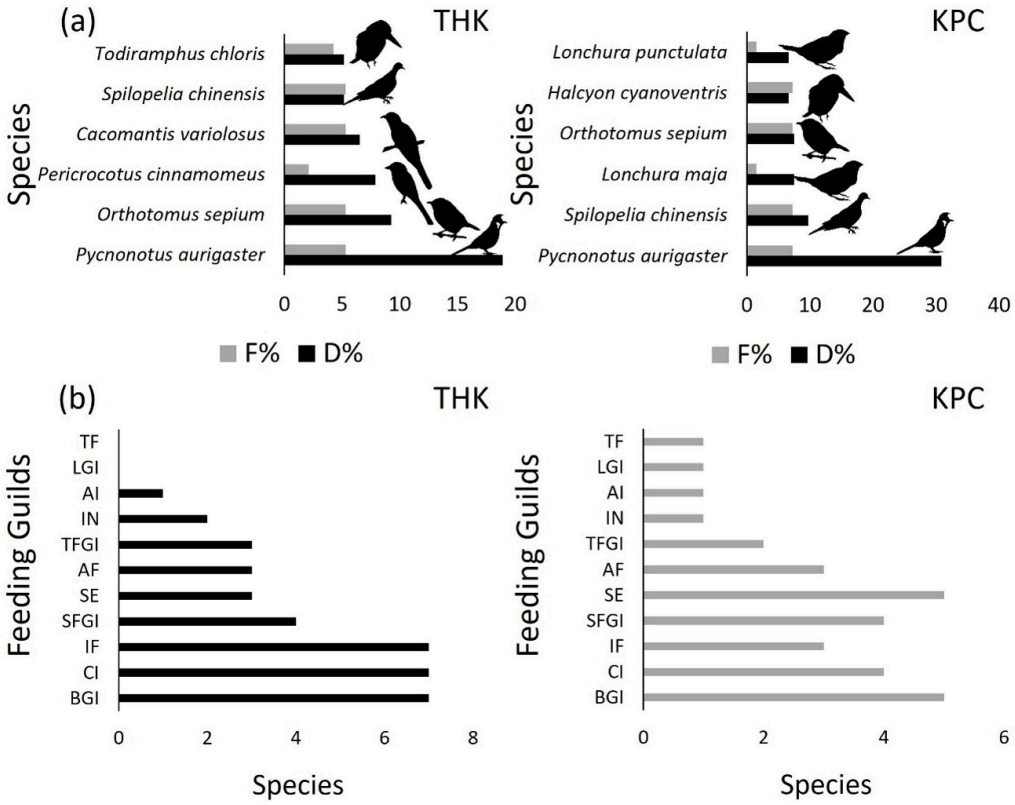

Figure 2. (a) The most dominant bird species (FR= frequency, D= dominance), and (b) comparison of feeding guilds in KPC and THK.

The use of space by birds based on their daily activities shows differences in the use of space between THK and KPC. The most dominant bird community activity in THK is Perching (67%), while in KPC, the most dominant activity is vocalization (90%). For dominant species, activity in THK and KPC differed, with *Spilopelia chinensis* showing the most dominant activity, perching in THK at 68% compared to 0.4% in KPC. Other *Spilopelia chinensis* activities in THK were sequentially dominated by vocalization (24.9%), preening (3.6%), feeding (1.6%), and flying (2%). Meanwhile, in KPC, other *Spilopelia chinensis* activities were sequentially dominated by vocalization (99%), flying (0.6%), and preening (0.2%). Differences in activity between the two locations were also evident with *Pycnonotus aurigaster*, particularly in preening activity, at 11.1% in THK compared to 0.7% in KPC. Other *Pycnonotus aurigaster* activities in THK were sequentially dominated by perching (79%), flying (3.9%), feeding (3%), and vocalization (3%). Meanwhile, in KPC, *Pycnonotus aurigaster* activities were sequentially dominated by perching (63%), flying (21%), vocalization (9.3%), and feeding (6%). The activity pattern was not different between the two locations, as shown with *Ortotomus sepium*, with vocalization being the dominant activity at 92.7% in THK compared to 100% in KPC. Other Ortotomus sepium activities in THK were sequentially dominated by perching (6.7%) and peering (0.5%).

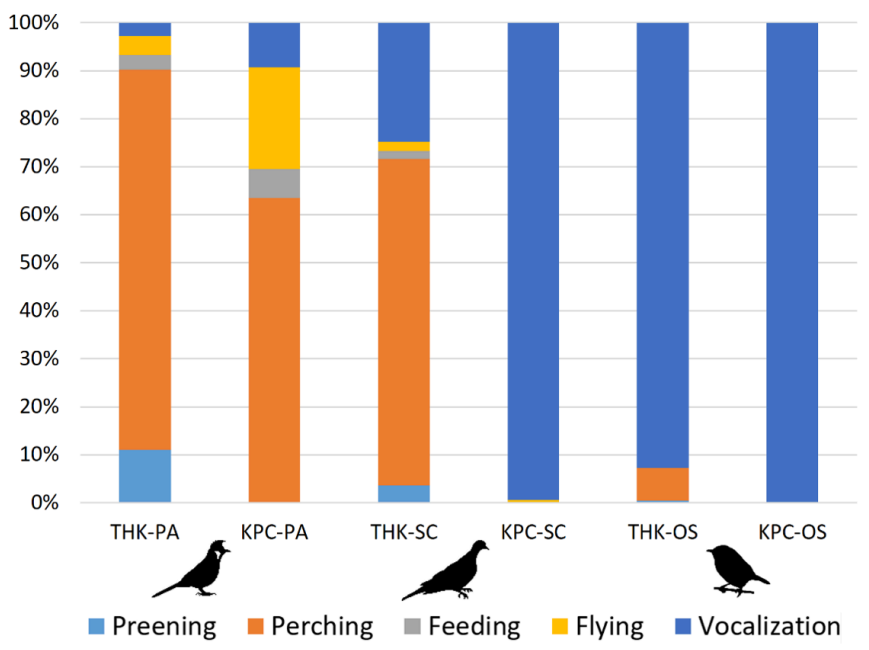

Figure 3. Comparison of space use in dominant species such as *Pynonotus aurigaster* (PA), *Spilopelia chinensis* (SC), and *Orthotomus sepium* (OS) in THK and KPC.

Bird Diversity

Three species are protected by Government Regulation, such as *Anthracoceros albirostris, Nisaetus cirrhatus* and *Spilornis cheela*. *Zosterops melanurus* were registered on the IUCN Red list as vulnerable status (IUCN, 2023). Then, based on the trade status of threatened species, *Bubo sumatranus, Nisaetus cirrhatus* and *Spilornis cheela* are classified as Appendix II. There is also a species that is endemic to Java Island, *Mixornis flavicollis* and three species endemic to Java and Bali Islands, *Loriculus pusillus, Zosterops melanurus* and *Halcyon cyanoventris*. Out of a total 42 bird species recorded, 37 were recorded at the THK and 32 at the KPC. The ratio of families between the THK and KPC was 23 and 19, with 291 individuals recorded compared to 227. Of all recorded bird species, several species have conservation status (Table 1). When we compared the diversity index (H) and evenness (E) among two locations (Table 1), the evenness and diversity index based on the mean values for the sampling point in each location did not differ between THK (H = 2.95 & E = 0.85) and KPC (H = 2.62 & E = 0.78). For the similarity index, it shows that both locations have almost similar species (75%).

Table1. List of bird species and diversity analysis values in KPC and THK, along with their conservation status

No	Family Common name (Latin)	Location		Data type*	Status			E**
		KPC	THK		IUCN	PP	CITES	
	Columbidae							
1	Spotted Dove (*Spilopelia chinensis*)	√	√	Ob	LC	n		
2	Zebra Dove (*Geopelia striata*)	√	√	Ob	LC	n		
3	Grey-capped Emerald Dove (*Chalcophaps indica*)	√		Ob	LC	n		
	Apodidae							
4	CaveSwiftlet (*Collocalia linchi*)	√	√	Ob	LC	n		
	Cuculidae							
5	Lesser Coucal (*Centropus bengalensis*)	√	√	Vc	LC	n		
6	Banded Bay Cuckoo (*Cacomantis sonneratii*)	√	√	Ob	LC	n		
7	Plaintive Cuckoo (*Cacomantis merulinus*)	√	√	Ob	LC	n		
8	Brush Cuckoo (*Cacomantis variolosus*)	√	√	Ob	LC	n		
9	Square-tailed Drongo-Cuckoo (*Surniculus lugubris*)	√	√	Ob	LC	n		
	Rallidae							
10	White-breasted Waterhen (*Amaurornis phoenicurus*)	√		Ob	LC	n		
11	Barred Eagle-owl (*Bubo sumatranus*)		√	Ob	NT	n	II	
	Accipitridae							
12	Crested Serpent-eagle (*Spilornis cheela*)	√	√	Ob	LC	P	II	

No	Family Common name (Latin)	Location KPC	 THK	Data type*	Status IUCN	 PP	 CITES	E**
13	Changeable Hawk-eagle (*Nisaetus cirrhatus*)		√	Ob	LC	P	II	
	Bucerotidae							
14	Oriental Pied Hornbill (*Anthracoceros albirostris*)	√	√	Ob	LC	P		
	Alcedinidae							
15	Blue-eared Kingfisher (*Alcedo meninting*)		√	Ob	LC	n		
16	Javan Kingfisher (*Halcyon cyanoventris*)	√	√	Ob	LC	n		JB
17	Collared Kingfisher (*Todiramphus chloris*)	√	√	Ob	LC	n		
	Megalaimidae							
18	Coppersmith Barbet (*Psilopogon haemacephalus*)	√	√	Ob	LC	n		
	Picidae							
19	Sunda Pygmy woodpecker (*Picoides moluccensis*)	√	√	Ob	LC	n		
20	Fulvous-breasted Woodpecker (*Dendrocopos macei*)		√	Ob	LC	n		
	Psittacidae							
21	Yellow-throated Hanging-parrot (*Loriculus pusillus*)	√	√	Ob	NT	P		JB
22	Red-breasted Parakeet (*Psittacula alexandri*)	√	√	Ob	NT	P		
	Campephagidae							
23	Small Minivet (*Pericrocotus cinnamomeus*)	√	√	Ob	LC	n		
	Vangidae							
24	Black-winget Flycatcher-shrike (*Hemipus hirundinaceus*)		√	Ob	LC	n		
	Aegithinidae							
25	Common Iora (*Aegithina tiphia*)	√	√	Ob	LC	n		
	Cisticolidae							
26	Bar-winged Prinia (*Prinia familiaris*)	√		Vc	NT	n		
27	Olive-backed Tailorbird (*Orthotomus sepium*)	√	√	Ob	LC	n		
	Pycnonotidae							
28	Ruby-throated Bulbul (*Rubigula dispar*)		√	Ob	LC	n		
29	Sooty-headed Bulbul (*Pycnonotus aurigaster*)	√	√	Ob	LC	n		
30	Yellow-vented Bulbul (*Pycnonotus goiavier*)		√	Ob	LC	n		
31	Cream-eyed Bulbul (*Pycnonotus simplex*)		√	Ob	LC	n		
	Zosteropidae							
32	Sangkar-White-eye (*Zosterops melanurus*)		√	Ob	VU	n		JB

No	Family Common name (Latin)	Location KPC	 THK	Data type*	Status IUCN	 PP	 CITES	E**
	Timaliidae							
33	Grey-cheeked Tit-babbler (*Mixornis flavicollis*)		√	Ob	LC	n		J
	Pellorneidae							
34	Rufous-browed Babbler (*Pellorneum capistratum*)	√	√	Ob	LC	n		
35	Horsfield's Babbler (*Malacocincla sepiaria*)	√	√	Ob	LC	n		
	Sturnidae							
36	Asian Glossy Starling (*Aplonis panayensis*)		√	Ob	LC	n		
	Dicaeidae							
37	Scarlet-headed Flowerpecker (*Dicaeum trochileum*)	√	√	Ob	LC	n		
	Nectariniidae							
38	Ruby-cheeked Sunbird (*Chalcoparia singalensis*)		√	Ob	LC	n		
39	Olive-backed Sunbird (*Cinnyris jugularis*)	√	√	Ob	LC	n		
	Estrilidae							
40	Scaly-breasted Munia (*Lonchura punctulata*)	√	√	Ob	LC	n		
41	White-headed Munia (*Lonchura maja*)	√		Ob	LC	n		
	Passeridae							
42	Eurasian Tree Sparrow (*Passer montanus*)	√		Ob	LC	n		
Total Species		**30**	**37**					
Total Order		**10**	**11**					
Total Families		**19**	**23**					
Total Individual (Point count)		**227**	**291**					
Shannon's Diversity Index (H')		**2.62**	**2.95**					
Pielou Evenness Index (E)		**0.78**	**0.85**					
Similarity Index		**75%**						

Data type* :

Ob: Observation; **Vc**: Voice

Status:

PP: Regulation of the Minister of Environment and Forestry; **P**: Protected **n**: non-protected

IUCN: International Union of Conservation of Nature; **NT**: near threatened; **VU**: vulnerable; **EN**: Endangered

CITES: Convention on International Trade in Endangered Species

E (Endemic)**:

J: Java

JB: Java and Bali

Figure 4. Documentation of several species of birds found at data collection locations; (a) Yellow-throated Hanging-parrot (*Loriculus pusillus*); (b) Oriental Pied Hornbill (*Anthracoceros albirostris*); (c) Javan rhinoceros Hornbill (*Buceros rhinoceros silvestris*) (A. Z. Subrata, in litt., 2022); (d) Cream-vented Bulbul (*Pycnonotus simplex*); (e) Ruby-throated Bulbul (*Rubigula dispar*); (f) Asian Glossy Starling (*Aplonis panayensis*).

DISCUSSION

Bird Community

KPC and THK have a similar number of orders and families, but there are about 12 species that were observed in THK. These include *Bubo sumatranus, Nisaetus cirrhatus, Alcedo meninting, Dendrocopos macei, Hemipus hirundinaceus, Rubigula dispar, Pycnonotus goiavier, Pycnonotus simplex, Zosterops melanurus, Mixornis flavicollis, Aplonis panayensis*, and *Chalcoparia singalensis*. Meanwhile, some species that are only found in KPC include *Chalcophaps indica* and *Amaurornis phoenicurus*, which are solitary species that generally search for food on the ground (Mackinnon et al., 2010), and other species such as *Prinia familiaris*, *Lonchura maja*, and *Passer montanus* like grasslands in open areas and are closely associated with humans (Mackinnon et al., 2010).

Differences in vegetation strata conditions are also reflected based on the presence of dominant bird species. However, the presence of *Pycnonotus aurigaster* dominates both locations, but this is more because this species is classified as a generalist species (Taufiqurrahman et al., 2022). In the floor plant strata dominated by shrubs, we found different shrub vegetation species at both locations, which are thought to affect the dominant bird species

that utilize the vegetation. The relatively more open forest floor conditions and abundant seeded weeds at the KPC location are preferred by *Spilopelia chinensis, Lonchura maja,* and *Lonchura punculata*, compared to non-seeded shrub vegetation at the THK location, which is dominated by insectivorous and caterpillar-eating species, such as *Orthotomus sepium*.

Comparing bird species in KPC and THK (Fig. 2b), it was found that agroforestry supported more bird species than oil palm plantations, which could be due to differences in the complexity of vegetation strata. These results align with various studies that state that birds prefer habitats with denser, complex vegetation with a canopy layer of vegetation, such as in natural forests. The community and diversity of bird species are strongly correlated with the complexity of vegetation in a habitat (Chettri et al., 2005). The complexity of heterogeneous vegetation strata and canopy cover stratification in agroforestry determines the distribution of resources in bird communities and influences bird diversity (Suroso et al., 2023; Hakim et al., 2020).

The most commonly observed bird species were forest generalist (18 species) followed by open-habitat generalist (14 species), forest specialist (5 species), and forest-edge species (4 species). In the guild classification, the majority of birds were insectivores (23 species), followed by granivores (7 species), frugivores (5 species), carnivores (4 species), and omnivores represented less than 8 % of the total number of species observed. This result is in line with the research results of Muhammad et al. (2013), which stated that insectivorous and frugivores are dominated in a forest-agricultural landscape of West Java, where most birds eat insects or use insects as an alternative food (Novarino, 2008).

Based on how birds obtain their food, we found specifically two categories are only found in KPC habitat: insect eaters looking for food in the litter or forest floor (LGI) and fruit eaters on the forest floor (TF). These habitat conditions support *Amaurornis phoenicurus* and *Chalcophaps indica* in foraging activities (Mackinnon et al., 2010). The condition of the KPC habitat, which has relatively dense stands and a reasonably clean floor area with only undergrowth, supports birds in utilizing the floor area to search for food. Shrub plants such as legumes positively correlate with increasing bird species diversity in oil palm plantations, especially for insectivores (Koh, 2008a). The presence of insect-eating birds in oil palm plantations can also provide benefits because it can reduce pests that eat oil palm leaves (Koh, 2008b).

More groups of seed-eating birds were observed at the KPC because the location is a more open area that provides food sources in the form of seeds, especially from plants of the

Gramineae family. Chettri et al. (2005) reported that seed-eating groups were positively correlated with habitats disturbed by human activities and open areas. Meanwhile, THK supports more insect eaters and fish or other vertebrates (CI) such as *Alcedo meninting* which prefer habitats near water and in forests (Taufiqurrahman et al., 2022) and fruit-eaters on the forest flora (IF) such as *Rubigula dispar* and *Pycnonotus goiavier* which prefer, except insect-eaters that search for food in the litter or forest floor (LGI) and eat fruit on the forest floor (TF).

Apart from that, social activities such as flocking were also observed at the observation location, more than one bird species in a group flew simultaneously and moved in search of food. Several species of birds involved include *Aegithina tiphia, Pericrocotus cinnamomeus, Pycnonotus simplex, Pycnonotus aurigaster, Hemipus hirundinaceus, Dicaeum trochileum*, and *Zosterops melanurus*. Flocking is often observed in THK and only once in KPC. The species that carry out flocking activities are a group of insectivorous birds, where different habitat conditions result in differences in foraging behavior (Castaño-Villa et al, 2019). Flocking benefits flocks of birds in finding food and reaching new areas because of the sharing of information, where the complexity of the habitat will influence how birds find their food (Gill et al., 2019).

The activity patterns differed between the two locations, indicated by the dominant species, *Spilopelia chinensis* and *Pycnonotus aurigaster*, while there were no differences indicated by *Orthotomus sepium*. Scooty-headed Bulbul (*Pycnonotus aurigaster*) lives in groups and likes open trees or shrub habitats, on the edge of forests, secondary plants, parks, and yards or even cities (Taufiqurrahman et al., 2022). In the morning, we observed this species in its sleeping tree (*Albizia chinensis*) in THK. After the sun rises, a small group of this species will gather at the top of the tree or even use dead trees to do perching and preening activities. This species group lives actively and noisily, so it is easy to observe. After doing preening activities in the morning, this species will look for food in the form of fruit on several types of liana plants, and we also found *P. aurigaster* eating oil palm fruit (*Elaeis guineensis*) that fell to the ground at the KPC location. Flying activity is much higher at the KPC location to move from one place to another, besides because this species has a territorial nature, we often find groups of this species also chasing away other birds that perch on their perches.

Eastern Spotted Dove (*Spilopelia chinensis*) is often observed alone, in pairs, or small groups. This species often walks on open ground or grass to forage (Taufiqurrahman et al., 2022). In the morning, this species often spends its time perching and peering among the shady tree canopies in THK, and during the day, it is observed more often foraging on the ground at

the KPC. Several times, we also found this species often chased away by *P. aurigaster* when perching on dead trees at KPC. Unlike the two previous dominant species, the Olive-backed Tailorbird (*Orthotomus sepium*) is often found alone or in pairs and prefers bushes and low canopies (Taufiqurrahman et al., 2022). The sleeping tree of this species was observed in the bushes at THK; after sunrise, this species was observed sunbathing among the low tree canopies at THK, and from noon to evening, this species was more often heard making sounds at the KPC location.

In this observation, the birds were very active in the morning. Birds are often observed perching on vegetation exposed to sunlight and carrying out other activities such as feeding and preening. Bird activity decreases as the intensity of sunlight increases, and during the day, they choose vegetation with a wide canopy for perching. This pattern is typical in bird activity. Birds avoid rising temperatures and hot light conditions, so they choose lusher vegetation (Walther, 2002). Stratification factors and vegetation composition greatly influence bird selection and use of habitat (Bibby et al., 1992). This reveals the critical function of large trees in the habitat in providing suitable locations for bird habitat use (Wang et al., 2022). Even though they can fill spaces they do not occupy, some birds choose not to inhabit a particular habitat. This causes its distribution to be limited by individual behavior in selecting its habitat (Krebs, 1985). Selection carried out on habitat is an individual bird's behavior aimed at providing comfort in life, in addition to other behaviors such as selection of food sources, preening behavior and playing behavior (Pettingill, 1967).

Bird Diversity

The populations of various bird species are facing a threat due to increasing hunting. Some of the species that are at risk include *Zosterops melanurus, Prinia familiaris*, and the endemic species *Loriculus pusillus* (Marshall et al., 2020; Suroso et al., 2023; Marsden et al., 2023). Additionally, *Anthracoceros albirostris, Spilornis cheela*, and *Nisaetus cirrhatus* are also facing a threat due to loss of natural habitat caused by deforestation and habitat transformation (Bachan, 2006; Supratman et al., 2023). These species have become targets of poaching throughout Asia and illegal trade (Bennett et al., 1997; Supratman et al., 2023). The presence of these species indicates that the site has good habitat quality. This is evidenced by the diversity index (H) and evenness (E) results at both locations, which are in the moderate category. We suspect that the two locations have diversity index values that are not different, which may be due to habitat variation at KPC, including watercourses, shrubs connecting the two sites, and even some dead trees at KPC that are utilized by species inhabiting both sites.

This is in line with the findings of Ramlah et al. (2021), who concluded that bird diversity in oil palm plantations is influenced by variations in habitat within them. The location of the THK and KPC are close together and allow birds to move from one location to another (Mustari, 2020).

Research on bird diversity at IPB Dramaga Campus was recorded from 1982 to 2023, with a total of 124 species (Putro, 1985; Mulyani, 1985; van Balen et al., 1986; Hernowo et al., 1991; Mulyani, 2001; Kurnia, 2003; Mulyani et al., 2013; Mustari, 2020), and our research adding five species (*Anthracoceros albirostris, Psilopogon haemacephalus, Rubigula dispar, Pycnonotus simplex,* and *Lonchura maja*) (Fig. 4) and unreported records of the findings of *Buceros rhinoceros silvestris* (A. Z. Subrata, in litt., 2022) bringing the total richness of bird species at IPB Dramaga to 130 species. However, the IPB Dramaga campus is included in the tropical peri-urban landscape in the Ciampea-Dramaga landscape, which has a relatively high bird diversity facing urbanization pressure (Nugroho et al., 2021). The IPB Dramaga campus area in the Ciampea-Dramaga landscape serves as a corridor for wildlife, including birds, due to it spatial design dominated by vegetation stands (Rahmandari et al., 2018). Besides that, IPB Dramaga Campus is around 25-30 km close to a location known for its high bird diversity and important bird areas (IBA), namely the Mount Halimun-Salak National Plant and the Mount Gede-Pangrango National Park (MacKinnon, 1995; Prawiradilaga et al., 2002; BirdLife International 2024). Apart from that, two other IBA locations bordered by Bogor city, namely Telaga Warna-Cibulao and Mount Pancar, are only about 25 km from IPB Dramaga campuses (BirdLife International, 2024). Locations with high bird diversity nearby have the potential to indirectly influence the bird community in the IPB Dramaga campus area, in line with the various habitats in it, thus attracting ornithologists to conduct research there. Due to the relatively high diversity in the research location, this area needs to be preserved and its habitat quality improved. One way is by rehabilitating complex structured vegetation strata with tall native tree canopies and several forest fruit trees such as *Ficus* spp.

In the following, we presented information on species that had a particular interest in this study from an ornithological perspective and conservation.

Bucerotidae

The closest population of Oriental Pied Hornbill (*Anthracoceros albirostris*) is in the Mount Halimun-Salak National Park (Prawiradilaga, 2017), and there have never been any records of this species on the IPB Dragama campus (Mulyani et al., 2013; Satria et al., 2021). It is generally only found in natural habitats in various types of lowland forests

(Taufiqurrahman et al., 2022), including oil palm plantations (Eaton et al., 2022). However, in the few cases of its presence in urban areas, Oriental pied Hordbill has been reported to have recolonized in Singapore (Lim 1998), and this success is partly due to the 'Singapore Hornbill Project' initiated in the late 2000s, which involved active reintroduction and provision of nest boxes (Cremades et al., 2011; Teo, 2012).

The presence of Hornbill species in the research area surrounded by urbanized areas indicates the potential carrying capacity for this forest specialist. We managed to observe two individuals with no signs of damage to the beak as the individual was trying to escape from the cage and no other markings were found such as on the legs or wings. This individual was observed flying around the oil palm plantation habitat and then perched on a *Durio* spp tree. A few days later we reencountered this species across THK at the data collection location. Because the encounter was relatively short, we only saw it briefly as it was perched and flew off. (Fig. 4). However, other reports show that the *Anthracoceros albirostris* eats the seeds or fruit of oil palms (*Elaeis* sp) and uses oil palm trees as resting trees (Niningsih, 2020).

Another Hornbill species that was also found in the IPB Dramaga is Javan Rhinoceros Hornbill (*Buceros rhinoceros silvestris*). This species was first observed on May 9 2022, at around 01.15 PM while resting and eating on the Bayan tree (*Ficus benjamina*) and Rubber tree (*Hevea brasiliensis*) around SMA Kornita IPB. Then, on May 10 it is suspected that the same individual was reencounter at the FAHUTAN IPB location perching on Burrflower tree (*Neolamarckia cadamba*) (A. Z. Subrata, in litt., 2022). The closest populaion of Javan Rhinoceros Hornill to the west is located in Mount Halimun-Salak National Park (eBird, 2024), while to the east, it is located on Mount Sanggabuana, Purwakarta Regency (Atlas Burung Indonesia, 2020).

Psittacidae

One species of bird rarely found in its natural habitat but observed in the agroforest habitat in the IPB Dramaga campus area is *Loriculus pusillus* and throughout the observation period we encountered 10 individuals. This parrot, endemic to Java and Bali, is now relatively difficult to find in its natural habitat in the mountains of Java (Marsden et al., 2023). Although this species tolerates habitat degradation and secondary forests, it is currently known to only occur in natural forest areas (Eaton et al., 2021; Collar & Boesman, 2020). Apart from that, hunting activities can also be a threat to the population of this species. This is in line with the increase in ownership of caged birds on the island of Java over the last decade (Marshall et al., 2020). Encounters with this parrot in THK occurred more than five times, with ten individuals

observed from 4 counting points. In addition, this species was also recorded in the yard habitat visiting guava tree flowers (*Syzygium aqueum*) and was not even disturbed by our presence (Fig. 4).

CONCLUSION

Our results show that habitat diversity in oil palm plantations (KPC), as well as agroforestry (THK) located close to oil palm plantations, can conserve forest bird communities and functional diversity to some extent. Although increasing forest area in the IPB Dramaga Campus area may be challenging, the remaining natural forests in THK need to be prioritized for quality improvement to conserve regional bird diversity and forest-dependent species in forest-agricultural landscapes. Nevertheless, the remaining forests in THK can maintain the species richness of various feeding-guild groups, thus providing essential ecosystem functions and services such as seed dispersal, biological pest control, and pollination.

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