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Research Article

Avifaunal Diversity and Community Structure in Universitas Brawijaya Forest, East Java, Indonesia

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ABSTRACT
Avifauna inhabiting the mountainous forest ecosystem is severely threatened by anthropogenic disturbances, especially in the Java island of --Indonesia. Yet, efforts to monitor the avifauna diversity are lacking, including in one of the mountainous forest areas, Universitas Brawijaya Forest (UBF). In this study, information about diversity, community structure, feeding specialization, and conservation status of avifauna is presented. Observations were conducted from December 2019 to February 2020 on two designated tracks with different degree of disturbances. Data were analyzed based on their conservation status, local distribution, feeding specialization (Jaccard similarity index), species richness, total abundance, species diversity (Shannon-Wiener diversity index), and importance value index (IVI). A total of 51 species from 27 families were identified. Two species at risk (one Near Threatened and one Endangered) and 9 protected avifauna were noted. This study can be used as the baseline data for future conservation management in the UBF.

Keywords: biodiversity, diet types, Malang, tropical bird

INTRODUCTION
Avifauna (birds) is one of the animal groups that has a diverse morphology and has been adapted to various landscapes (Coates et al. 2000). Even more, the avifauna can be used as a bioindicator to assess environmental changes (Kurniawan & Arifianto 2017). In this case, the decline of avifauna populations will reflect detrimental changes in the ecosystems (Labe et al. 2018). Several characteristics of avifauna, e.g., feeding specialization, ecological niche, abundance, density, and diversity in populations are considered as the major indicators of environmental change. Thus, avifauna promises good assessment tools to reflect the quality of the environment (Scott 2010).

Currently, there are 494 species of avifauna recorded in Java, 28% of them are confined in mountainous areas (MacKinnon et al. 2010). In this mountainous area, avifauna provides ecosystem services by spreading plant seeds, controlling insect populations, pollinating flowering plants, etc.; while several species act as apex predators (Fjeldsa et al. 2012). However, the habitat of avifauna in mountainous areas has been severely impacted by land

conversion, deforestation, and illegal hunt (Kurniawan & Arifianto 2017; Kementerian Lingkungan Hidup dan Kehutanan 2019; Iskandar et al. 2019). Due to the anthropogenic effects, avifauna conservation is urgently needed.

Universitas Brawijaya Forest (UBF) serves as an education forest under the management of Universitas Brawijaya. These areas span 554 ha with elevations ranging between 800–1200 m asl (Putri et al. 2019), comprising both a tropical and sub-montane zone (Gőltenboth et al. 2006). Due to its location at the intersection of the agroforestry ecosystem of the Arjuno mountain slope, and the conservation area of Raden Soerjo Forest Park, the UBF serves as an important bird and biodiversity area (IBA) (BirdLife International 2020). Prominent threats to the biodiversity in UBF have been reported, e.g., volcanic activity and forest fire (Febriandhika et al. 2019). Yet, the information on avifauna and their community in UBF are unavailable. Therefore, we monitored the avifauna in the UBF to provide the baseline data for avifauna conservation management, based on diversity, conservation status, feeding specialization, and community structure.

MATERIALS AND METHODS

Study area

The research was conducted on the west side of the UBF which administratively belongs to Tawang Argo in Karangploso of East Java. Field observation was carried out on two designated tracks. The starting point of these tracks was around the residential area (7°49'30.47" S; 112°34'43.45" E). Track 1 leads to the highest point of UBF near Raden Soerjo Forest Park area (7°49'14.58" S; 112°34'43.41" E), with an approximate track length of 0.5 km. Whereas Track 2 leads to Mountain Mujur site (7°49'27.62" S; 112° 34'56.31" E) with approximately similar length to Track 1 (Figure 1). Track 2 is adjacent to the main road and had a higher disturbance than Track 1, the latter being far from human activities. The habitats of UBF are dominated by human settlement, coffee plantation, pine forest, and sub-montane forest (Figure 2).

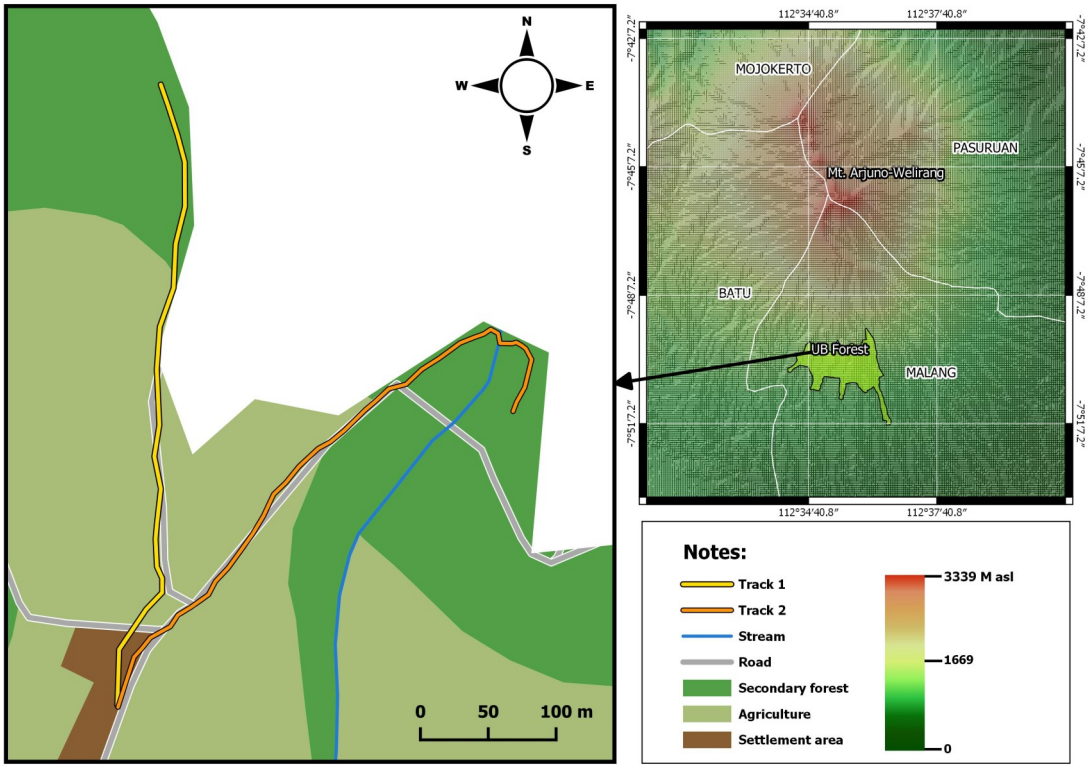

Figure 1. Study sites of avifauna monitoring in the UBF showing the observation track, land use pattern, and elevation.

Figure 2. Representative habitats in the UBF: A) human settlement, B) coffee plantation, C) pine forest, and D) sub-montane forest.

Field observation and species identification

Avifauna observation was conducted in December 2019–February 2020 for two consecutive days every week. The observation was started in the morning (06.00–08.00 am) due to the peak activities of birds (MacKinnon et al. 2010). The line transect method (Buckland et al. 2008) was chosen, then observed by 3–5 observers. The observation was aided by standard equipment, i.e., Binocular 10x50D, camera (NIKON D5200), and telephoto lens (Tamron 150-600 mm). The sounds of the birds were recorded using Sony ICD-PX240. The identification was based on the bird morphology (size, proportion, shape, beak, leg, and color pattern) following several references (MacKinnon et al. 2010; Kurnianto et al. 2013; Prasetya et al. 2018), Burungnesia v.3.0. application (Andriutomo et al. 2020), and sound confirmed by Xenocanto database (https://xeno-canto.org//). The individual encounters, their habitats, and feeding specialization on both tracks were noted, then subjected for further analysis.

Data analysis

The avifauna species were grouped by taxa. The conservation status was based on International Union for Conservation of Nature (IUCN 2020) and national laws under the Permen LHK No.106 (Balai KSDAE 2018). The local distribution categorization (e.g., migrant and resident) of birds was based on Burungnesia v.3.0 (Andriutomo et al. 2020). The feeding specialization of birds was categorized as follows: carnivores, insectivores, frugivores, granivores, and nectarivores (MacKinnon et al. 2010), were clustered using the presence or absence matrix by the Jaccard similarity index through Unweighted Pair Group Method with Arithmetic mean (UPGMA) analyzed on PAST3 software. The data were further analyzed to estimate the species richness, total abundance, Shannon-Wiener diversity index following their respective categorization (Heip et al. 1998), along with the importance value index (IVI) analysis (Misra 1980) to investigate the community structure on both tracks.

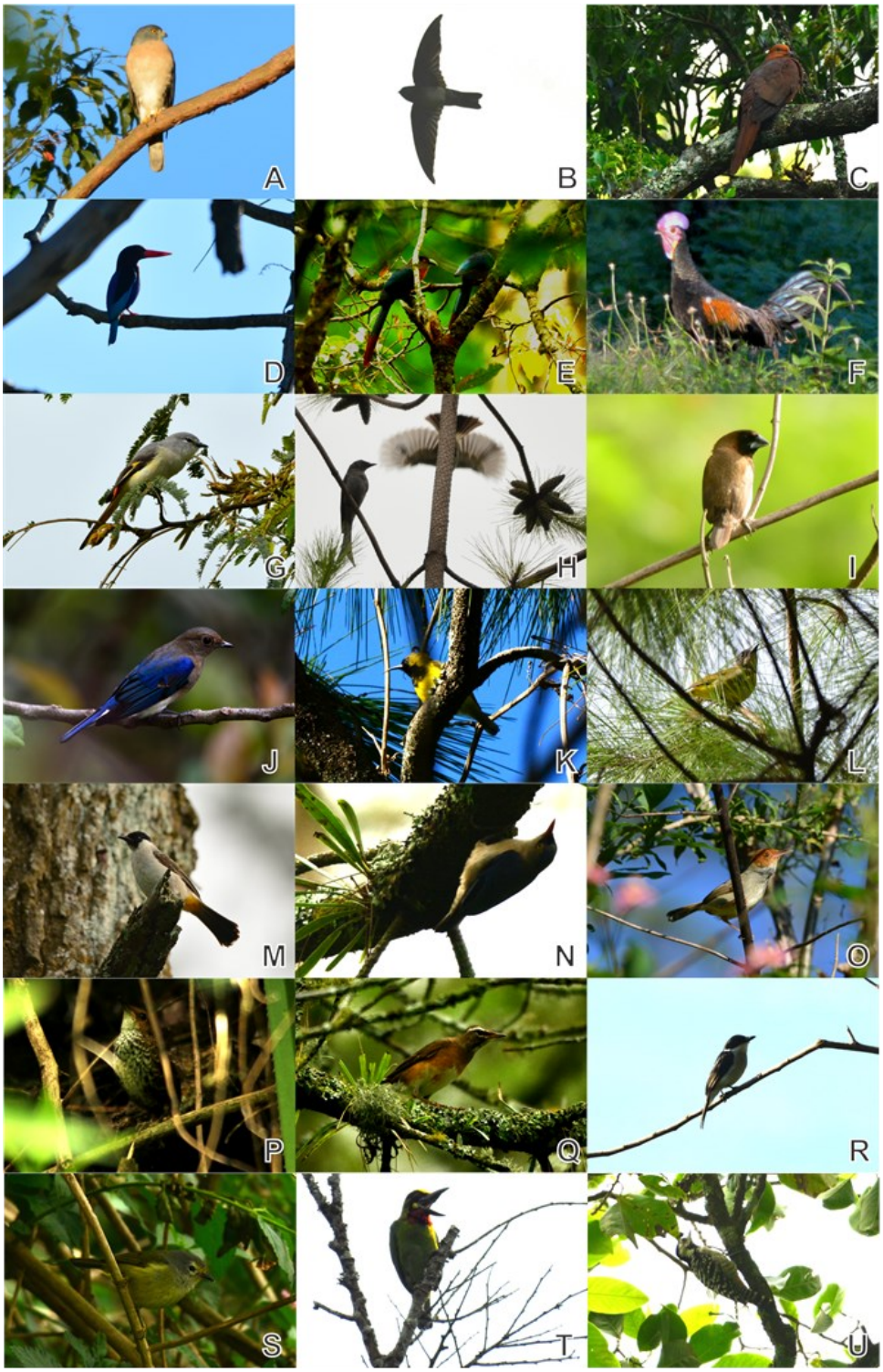

Figure 3. Documentation of representative avifauna species in UBF: A) *A. soloensis* [Accipitridae], B) *C. linchi* [Apodidae], C) *M. emiliana* [Columbidae], D) *H. cyanoventris* [Alcedinidae], E) *P. curvirostris* [Cuculidae], F) *G. varius* [Gallidae] G) *P. cinnamomeus* [Camphephagidae], H) *D. leucophaeus* [Dicruridae], I) *L. leucogastroides* [Estrildidae], J) *C. cyanomelana* [Muscicapidae], K) *C. jugularis* [Nectariniidae], L) *P. fulvocincta* [Pachycephalidae], M) *P. aurigaster* [Pycnonotide], N) *S. frontalis* [Sittidae] O) *O. sepium* [Sylviidae] P) *P. pusilla* [Timaliidae], Q) *T. obscurus* [Turdidae], R) *H. hirundinanceus* [Vangidae], S) *H. javanica* [Zosteropidae], T) *P. javensis* [Capitonidae], U) *D. analis* [Picidae].

RESULTS AND DISCUSSION

Avian Community in UBF

Field observation from both tracks counted a total of 1525 individuals of birds under 51 species from 27 families in UBF (Table 1). This number

represented 27% of 186 species in the mountainous habitat range of East Java (MacKinnon et al. 2010; Prasetya et al. 2018). The representative avifauna documentation is shown in Figure 3.

The IUCN conservation status shows that 49 species were categorized as least concern, one species (i.e., *P. javensis*) categorized as near-threatened and one species (i.e., *N. bartelsii*) categorized as endangered (Table 1). Those two species, along with the other seven species (i.e., *A. soloensis, A. gularis, S. cheela, P. ptilorynchus*, *P. guajana, H. javanica,* and *M. armillaris),* were classified as protected birds according to the national law of Indonesia (Table 1). Based on the local distribution, eight species (i.e., *A. soloensis, A. gularis, P. ptilorynchus, C. saturatus, C. cyanomelana, M. dauurica, F. mugimaki*, and *T. obscurus*) were migratory while the remainders were resident species (Table 1). This migratory avifauna originated from North Asian Peninsula which comes in large flocks temporarily to avoid winter from their native place during November–February cycle (Elphick 2011). The UBF provides an ideal resting place for this migratory avifauna.

Table 1. Checklist of the avifauna in the UBF based on conservation status, local distribution, and feeding specialization. Abbreviation as follows: Conservation status: IUCN Status = least concern (LC), near threatened (NT), endangered (EN); National law status = protected (P), non-protected (NP). Local distribution= migrant (M), resident (R). Feeding specialization= carnivores (C), insectivores (I), granivores (G), frugivores (F), nectarivores (N).

Taxa	Common name	IUCN Status	National law status	Local distribution	Feeding specialization				
					C	I	F	G	N
Accipitridae									
Accipiter soloensis	Chinese sparrowhawk	LC	P	M	√				
A. gularis	Japanese sparrowhawk	LC	P	M	√				
Spilornis cheela	Crested-serpent eagle	LC	P	R	√				
Nisaetus bartelsii	Javan-hawk eagle	EN	P	R	√				
Pernis ptilorynchus	Oriental-honey buzzard	LC	P	M	√				
Apodidae									
Collocalia linchi	Cave swiftlet	LC	NP	R		√			
Hemiprocnidae									
Hemiprocne longipennis	Grey-rumped treeswift	LC	NP	R		√			
Columbidae									
Streptopelia chinensis	Spotted dove	LC	NP	R			√	√	
Macropygia emiliana	Ruddy cuckoo-dove	LC	NP	R			√	√	
M. ruficeps	Little cuckoo-dove	LC	NP	R			√	√	

Table 1. Contd.

Taxa	Common name	IUCN Status	National law status	Local distribution	Feeding specialization				
					C	I	F	G	N
Alcedinidae									
Halcyon cyanoventris	Javan kingfisher	LC	NP	R	√	√			
Todiramphus chloris	Collared kingfisher	LC	NP	R	√	√			
Cuculidae									
Pahenicophaeus curvirostris	Chestnut-breasted malkoha	LC	NP	R		√			
Cuculus saturatus	Himalayan cuckoo	LC	NP	M		√			
Cacomantis merulinus	Plaintive cuckoo	LC	NP	R		√			
C. sepulcralis	Rusty-breasted cuckoo	LC	NP	R		√			
Gallidae									
Gallus varius	Green junglefowl	LC	NP	R	√	√	√	√	
Aegithinidae									
Aegithina tiphia	Common Iora	LC	NP	R		√			
Campephagidae									
Coracina larvata	Sunda cuckooshrike	LC	NP	R		√	√		
Pericrocotus cinnamomeus	Small minivet	LC	NP	R		√			
Cettidae									
Horornis vulcanius	Sunda bush-warbler	LC	NP	R		√			
Dicaeidae									
Dicaeum sanguinolentum	Blood-breasted flowerpacker	LC	NP	R		√			√
Dicruridae									
Dicrurus leucophaeus	Ashy drongo	LC	NP	R		√			
Estrildidae									
Lonchura leucogastroides	Javan munia	LC	NP	R			√	√	
L. punctulate	Scaly-breasted munia	LC	NP	R			√	√	
Locustellidae									
Locustella montis	Sunda grasshopper-warbler	LC	NP	R		√			
Muscicapidae									
Brachypteryx leucophrys	Lesser shortwing	LC	NP	R		√			
Myophonus caruleus	Blue whistling-thrush	LC	NP	R		√			
Enicurus velatus	Sunda forktail	LC	NP	R		√			
Ficedula westermanni	Little-pied flycatcher	LC	NP	R		√			
Cyanoptila cyanomelana	Blue-and-white flycatcher	LC	NP	M		√			
Muscicapa dauurica	Asian-brown flycatcher	LC	NP	M		√			
Ficedula mugimaki	Mugimaki flycatcher	LC	NP	M		√			

Table 1. Contd.

Taxa	Common name	IUCN Status	National law status	Local distribution	Feeding specialization				
					C	I	F	G	N
Nectariniidae									
Cinnyris jugularis	Olive-backed sunbird	LC	NP	R		√			√
Pachycephalidae									
Pachycephalia fulvotincta	Rusty-breasted whistler	LC	NP	R		√			
Pittidae									
Pitta guajana	Javan-banded pitta	LC	P	R		√			
Pcynonotidae									
Ixos virescens	Sunda bulbul	LC	NP	R		√	√		√
Pycnonotus aurigaster	Sooty-headed bulbul	LC	NP	R		√	√		√
P. goiavier	Yellow-vented bulbul	LC	NP	R		√	√		√
Sittidae									
Sitta frontalis	Velvet-fronted nuthatch	LC	NP	R		√			
Sylviidae									
Orthotomus sepium	Olive-backed tailorbird	LC	NP	R		√			
O. sutorius	Common tailorbird	LC	NP	R		√			
Timaliidae									
Pnoepyga pusilla	Pygmy-wren babbler	LC	NP	R		√			
Malacocincla sepiarium	Horsfield's babbler	LC	NP	R		√			
Cyanoderma melanothorax	Crescent-chested babbler	LC	NP	R		√			
Turdidae									
Turdus obscurus	Eye-browed thrust	LC	NP	M		√			
Vangidae									
Hemipus hirundinanceus	Black-winged flycatcher shrike	LC	NP	R		√			
Zosteropidae									
Heleia javanica	Javan Grey-throated White-eye	LC	P	R		√	√	√	√
Capitonidae									
Megalaima armillaris	Flame-fronted barbet	LC	P	R			√	√	
Psilopogon javensis	Black-banded barbet	NT	P	R			√	√	
Picidae									
Dendrocopos analis	Freckle-breasted woodpecker	LC	NP	R		√			

The clustering on feeding specialization reveals as follows: carnivores covered 3 families (1 family is specific), insectivores covered 23 families (16 families are specifics), frugivores covered 7 families, granivores covered 5 families, and nectarivores covered 4 families (Figure 4). The insectivore dominated the niche (along with 7 families that are non-specifics) due to the presence of agroforestry plantation (e.g., coffee plantation and vegetable agroforestry) in UBF which attract insects, providing a nutrition source for avifauna. As for the secondary forest, it provides canopies for avifauna to perch to feed on prey (Poo et al. 2012). Moreover, UBF provides a suitable condition (i.e., temperature, humidity) for the insect's abundance (Rosenthal 2004; Jaworski & Hilszczański 2013).

Track 1 had higher species richness than Track 2 (Figure 5). A total of 31 bird species were found on both tracks, but twelve species can only be found on Track 1, i.e., *S. cheela, P. ptilornychus, H. longipennis, G. varius, A. tiphia, D. sanguinolentum, F. westermanni, P. fulvotincta, I. virescens, H. javanica,* and *M. armillaris*. While 8 species can only be found on Track 2, i.e., *A. gularis, N. bartelsii, C. larvata, L. leucogastroides, L. punctulate, M. dauurica, M. caruleus,* and *E. velatus*. The total abundance shows the higher individual of birds founds on Track 1 than on Track 2 (Figure 5). The Diversity index showed a high value on Track 1 (H' > 3) than on Track 2 (H' < 3) (Heip et a1. 1998) (Figure 5).

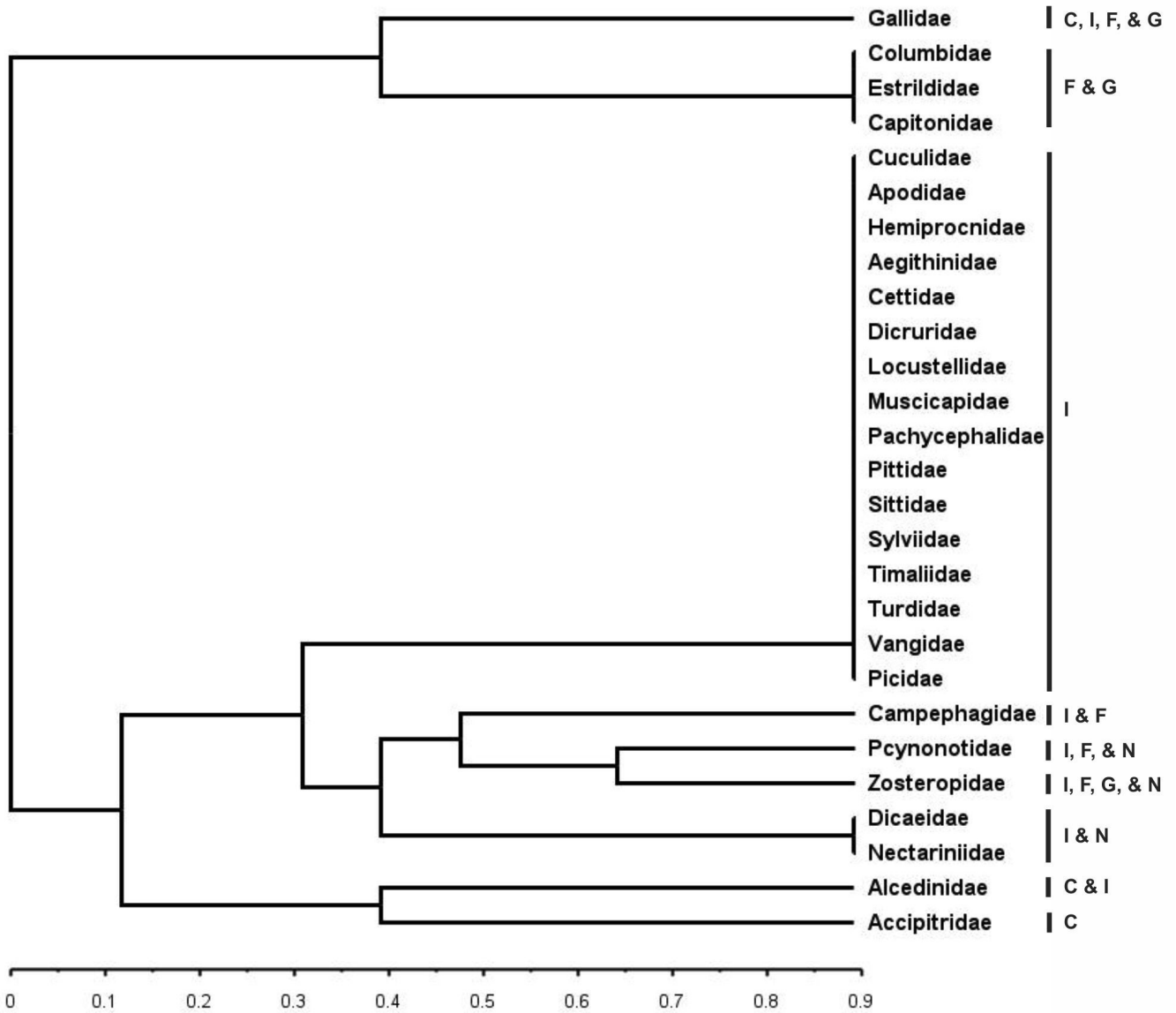

Figure 4. Clustering of feeding specialization based on the family of avifauna in the UBF. Abbreviation as follows: carnivores (C), insectivores (I), frugivores (F), granivores (G), and nectarivores (N).

The enormous amount of species diversity highlights the importance of UBF as a refuge spot for avifauna of mountainous forests in Java.

The range on the important value index reflects the actual conditions on each observation track. It shows that out of 27 families, Pycnonotidae had the highest important value on both tracks followed by Campephagidae and Timaliidae, respectively (Figure 6). Pycnonotidae and Campephagidae have similar common strategies which are living in colonies (except for *C. larvata* that are living in solitary). However, Pycnonotidae is more adaptive due to the wider range of feeding specialization (i.e., insectivore, frugivore, and nectarivore), while Campephagidae is limited to insectivore and frugivore (MacKinnon et al. 2010).

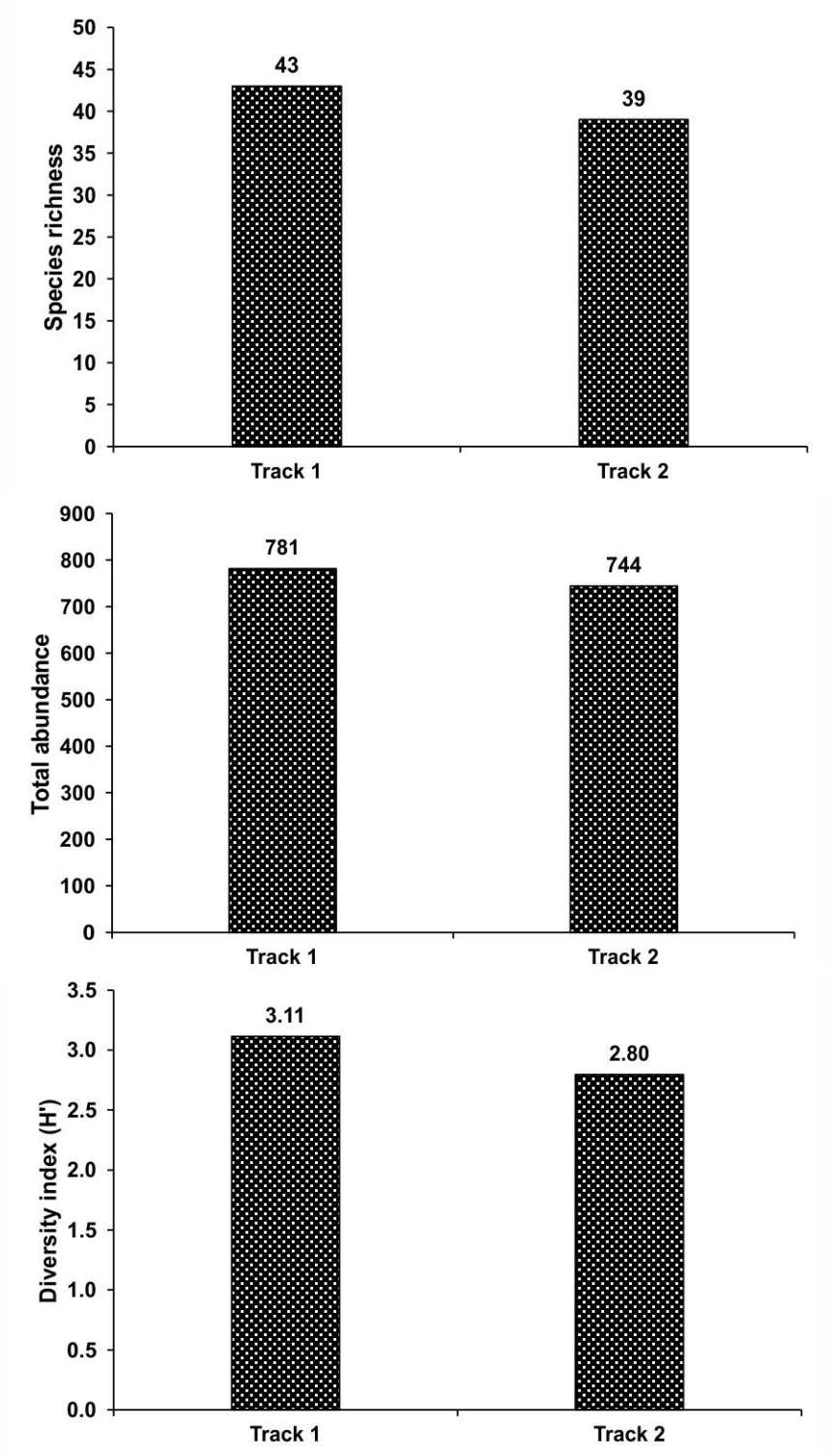

Figure 5. Comparison of species richness, total abundance, and diversity index of avifauna on both two tracks in the UBF.

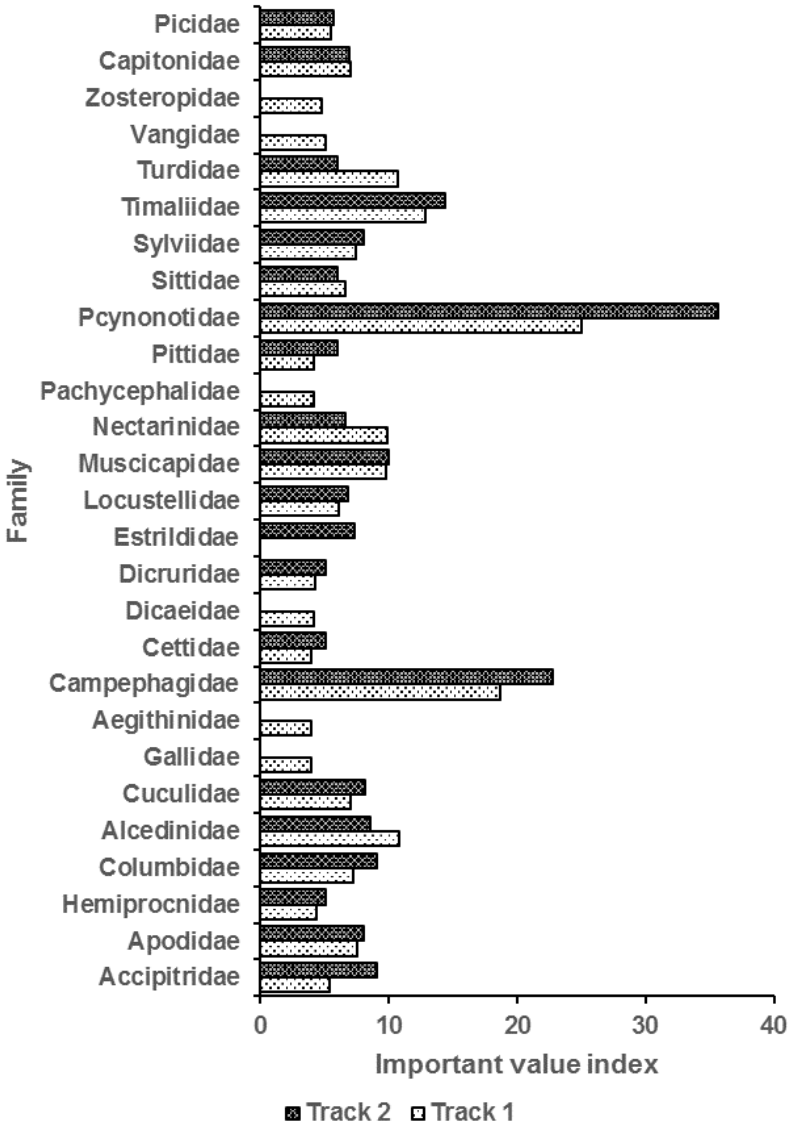

Figure 6. Comparison of the Important value index (IVI) of avifauna on two study tracks in the UBF.

Factor affecting the avifauna community and future conservation

The differences of avifauna composition—based on many indicators observed on both tracks, are associated with three main factors, i.e., habitat and vegetation composition, interactions between species, and presence of stress (Scott 2010). The UBF vegetation is comprised of two different ecosystems. The transition between the lower montane forest (upper side area) and the agricultural area (lower side area) affects the vegetation structures required for avifauna daily activities. The activities of each avifauna species are also related to the adaptation response of other bird species and the interactions among species (e.g., association, predation, and competition), thus shaping the community structure (Sutherland et al. 2004). Despite that, both tracks had different degrees of disturbances. Track 1 had less human disturbance due to its difficult terrain and dense canopy (Figure 2D), while Track 2 had higher human disturbance due to its location near the main road (Figures 2A, 2C). The disturbed areas have been reported to reduce the abundance and the amount of avifauna (Nuñeza et al. 2019). Moreover, Track 2 habitat is isolated by the main roads crossing the natural valley. The absence of a green corridor may limit avifauna mobility in exploring the diverse habitats. Also, birds prefer to fly higher or crossing over quiet roads to avoid the risk of being killed or struck (Reijnen & Foppen 1997).

The conservation effort of avifauna in UBF must be developed immediately through the collaborative and coordinative approach (Kristanti et al. 2017) to minimize the negative effect of anthropogenic disturbances (Estrada et al. 1997). Several things that could improve the conservation of avifauna in UBF, e.g., synergistic collaborations between the local community, institutions, and researchers. It can be succeded through regular monitoring, education, good governance, also by improving research effort in the UBF area.

CONCLUSION

A total of 51 species from 27 families were identified. Two species at risk (one Near Threatened and one Endangered) and 9 protected avifauna were noted. This study can be used as the baseline data for future conservation management in the UBF. The study on microclimatic factors, spatial and temporal distribution, and species interaction of avifauna is recommended in the future.

AUTHORS CONTRIBUTION

A.N. and M.F. designed the research, collect and analyzed the data. A.N. wrote the initial manuscript. L.S. and A.S.K. reviewed, revised, and proofread the final manuscript. N.K. supervised all the process.

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CONFLICT OF INTEREST

The authors confirm that there are no known conflicts of interest associated with this publication and there has been no financial support for this work that could have influenced its outcome.

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