Insectivorous Birds in Edge and Interior Habitats of Forest Plantation in Gunung Walat, Sukabumi

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Abstract. Among forest birds, insectivorous birds are known to be most affected by habitat fragmentation. This study aimed at examining insectivorous bird communities in edge and interior habitats of a forest plantation. Monthly observation was conducted from January to June 2010 in Gunung Walat Education Forest, Sukabumi, to record bird community using point count method with a fix radius of 30m for 15 minutes. Observation points were placed in each of edge and interior habitats of broadleaves Schima wallichii and conifer Agathis damara stands. Arthropod sampling was done twice using window traps and yellow panes. A total of 44 bird species of 19 families were identified in the study plots, in which 54% (24 species) were insectivores. A higher bird abundance and richness were recorded in edge habitat. A positive correlation was found between the total number of birds and total number of arthropods. However, the richness of insectivorous species tends to be lower in edge habitats. There were also differences in insectivorous bird community between types of stands, with broadleaves stand had a higher species richness compared to conifer.

1. Introduction

Alteration of forest habitats into other land use has created fragments of habitat patches that negatively impact forest bird community. The creation of edge habitat a consequence causes changes in vegetation structure and composition, increase chance of predation and brood parasitism that affect bird community. Habitat edges formed by fragmentation will promote changes in microclimate in the surrounding matrices. Understorey birds that mainly feed on insects are highly affected by forest fragmentation [1, 2, 3] because fragmentation reduced arthropod abundance as birds’ food resource. Lindell et al. [4] explained that compared to other feeding group, understorey insectivores are more restricted in their movement, and tend to avoid edge habitats. The creation of edge habitat might reduce food availability that ultimately cause species loss in forest fragments [5].
While the decline in natural forest habitat reduce habitat suitable for wildlife, the creation of forest plantations in some areas may create patches of habitat fragments that will be useful for bird community living in the forest. However, most plantation forests are monoculture or only few species in mixed plantation forest. Many studies have showed that bird diversity in plantation differs from those in natural forests, and that different is due to different in vegetation structure [e.g. 6, 7]. The objectives of this study are to examine whether there is any difference in bird diversity and abundance between different plantation forest types and location between fragments, and to examine whether there is any difference in arthropod diversity and abundance between different plantation forest types and location between fragments.

2. Method

2.1. Study site
This study was conducted in a forest plantation in Gunung Walat Education Forest (GWEF), Sukabumi. (106°48'27''E - 106°50'29''E and 6°54'23''S - 6°55'35''S). It is located at the elevation of 460-715 m above sea level. The 349-ha forest has been planted since 1951/1952 and is surrounded by agricultural landscape and human settlements, placing the area as a habitat island. Administratively GWEF is located in the Subdistrict of Cibadak, District of Sukabumi, while based on forestry administration it is located within the Forestry Agency of Sukabumi District. The plantation consisted of several species dominated by Pine tree Pinus merkusii, Copal Agathis loranthifolia, and Schima tree Schima wallichi. Other species include Umbrella tree Maesopsis eminii, Mahogany Swietenia macrophylla, Rasamala Altingia excelsa, etc. Observation plots were placed in Copal stand to represent conifers and Schima stand to represent broad leaves stands. Pine stand was not chosen because it was scattered in several locations with lower accessibility. Edge habitat of those stands are mixed species of agroforestry plantation and agricultural land.

2.2. Bird Data Collection
Monthly observation was done from January to June 2010 by using point count with fixed radius of 30 m. Points were located at least 100 m apart to minimize the chance of double counting. Ten points were used in each habitat type per month. Exception was in January where there were only six points in edge of Schima and eight points in interior habitat of Agathis. The duration of counting in each plot was 15 minutes.

Birds seen (using binoculars 8x42) and/or heard within the radius were recorded. Data recorded included species, number of individuals, activities and position or location of individual bird in the habitat. Bird identification and naming followed MacKinnon and Phillipps [8]. Feeding guild was categorized according to food type described in MacKinnon [9].

2.3. Arthropod Sampling
Bi-monthly collection of arthropods using two types of traps was conducted: window trap (funnel trap), and yellow pan. Window trap was set up at the height of 5 m above the ground to target flying insects. Five traps were placed in each habitat type. Yellow-pan trap (size 24 x 20 x 6 cm) was placed on the forest floor for ground arthropods. Each pan was filled with water, detergent and sorbic acid. Five traps were set in each habitat. Those traps were left in the habitat for three days before checking. However, during the course of the collection some traps were vandalized, so that at the end the number of traps was not equal in every sampling effort. Sticky trap was tried at the first sampling effort, but most of the insects collected by this were damaged due to strong adhesive. Therefore, this method was no longer used.

2.4. Data Analysis
The number of species and Shannon index of diversity (H') were used to express bird and arthropod diversity. The evenness index € was also calculated. One-way ANOVA was used to examine if there is
any difference among habitat types in insectivorous bird abundance and number of species. A correlation analysis was conducted to examine the relationship between bird abundance and arthropod abundance. Analysis was done using PAST 3.26.

3. Result and discussion

3.1. Bird community
A total of 44 bird species of 19 families have been identified in the four study plots. Based on major diet, 24 species (54 %) of 10 families were insectivores (Table 1), while 12 were species that usually include insects in their regular diet. Others are carnivores, frugivores and granivores, which might include insects in their diet.

Table 1. List of insectivorous bird species recorded during the study in Gunung Walat Education Forest

| Family            | No. | Common Name             | Scientific Name                        |
|-------------------|-----|-------------------------|----------------------------------------|
| Cuculidae         | 1   | Banded Bay Cuckoo       | Cacomantis sonneratii                   |
|                   | 2   | Plaintive Cuckoo        | Cacomantis merulinus                    |
|                   | 3   | Rusty-breasted Cuckoo   | Cuculus sepulcralis                     |
|                   | 4   | Drongo-Cuckoo           | Surniculus lugubris                     |
|                   | 5   | Chestnut-breasted Malkoha | Phaenicophaeus javanicus               |
|                   | 6   | Lesser Coucal           | Centropus bengalensis                   |
| Apodidae          | 8   | Glossy Swiftlet         | Collocalia linchi                      |
|                   | 9   | Needle-tail             | Hirundapus sp                          |
| Campephagidae     | 10  | Small Minivet           | Pericrocotus cinnamomeus                |
|                   | 11  | Common Iora             | Aegithina tithia                       |
| Dicruridae        | 12  | Black Drongo            | Dicrurus macrocercus                    |
|                   | 13  | Ashy Drongo             | Dicrurus leucophaeus                    |
| Sittidae          | 14  | Velvet-fronted Nuthatch | Sitta frontalis                        |
| Timaliidae        | 15  | Black-capped Babbler    | Pellorneum capistratum                  |
|                   | 16  | Horsfield’s Babbler     | Malacocincla sepium                     |
|                   | 17  | White-breasted Babbler  | Stachyris grammiceps                   |
| Turdidae          | 18  | Siberian Thrush         | Zoothera sibirica                      |
| Sylviidae         | 19  | Golden-bellied Gerygone | Gerygone sulphurea                     |
|                   | 20  | Common Tailorbird       | Orthotomus sutorius                    |
|                   | 21  | Olive-backed Tailorbird | Orthotomus sepiarium                   |
|                   | 22  | Plain Prinia            | Prinia inornate                        |
|                   | 23  | Bar-winged Prinia       | Prinia familiaris                      |
| Musicicapidae     | 24  | Pied Fantail            | Rhipidura javanica                     |
| Zosteropidae      | 25  | Oriental White-eye      | Zosterops palpebrosus                  |

Insectivorous bird abundance, species richness and diversity varied between locations (Figure 1; Table 2). In general birds were more abundant in edge habitats, with the highest abundant in edge of Schima habitat. A one-way ANOVA showed that there was a significant difference in bird abundance among habitats ($F_{3,226}=12.7; p<0.01$). In both stands, more birds were recorded in edge habitats than interior habitat. However, there was no significant difference in the number of bird species among habitats ($F_{3,226}=2.033, p>0.05$).
Figure 1. Variation of number of birds among habitats (SE= Edge of Schima, SI= Interior of Schima, AE= Edge of Agathis, AI= Interior of Agathis)

Table 2. Bird species richness and diversity in edge and interior habitats of Agathis and Schima stands

| Location | Stand | S | D_Mg | H’  | E    |
|----------|-------|---|------|-----|------|
| Edge     | Agathis | 15 | 2.302 | 1.920 | 0.709 |
|          | Schima  | 18 | 2.998 | 2.621 | 0.907 |
| Interior | Agathis | 15 | 2.424 | 2.092 | 0.772 |
|          | Schima  | 19 | 3.049 | 2.198 | 0.709 |

Berry [10] also found a higher number of birds in edge habitats because of higher number of species that inhabit more open habitat. Higher insectivorous bird diversity in interior habitats of tropical forests was reported by Mansor and Sah [11] and Moradi et al. [12]) who suggested the importance of abiotic factors and forest cover in determining bird diversity. The difference also indicated that edge habitat might negatively affect the insectivorous bird diversity. This study did not show significant difference in bird species richness and diversity between edge and interior habitats. The fact that this study was conducted in plantation forest might be an important factor, because plantation forest is reported to have lower bird diversity than natural forests [13]. Variation in bird diversity in different type of plantation has also been reported in previous studies [14]. Kaban et al. [15] revealed that Schima stand had a higher bird diversity compared to Agathis stand in Gunung Walat Education Forest due to more complex structure in Schima stand.

3.2. Arthropod community

Samples collected from all traps set in forest habitats varied considerably at level of individuals and orders. Total catches of insects were 1378, 920, 2080, 1372 specimens from AE, AI, SE, and SI, respectively. The dominant orders were Collembola, Diptera and Hymenoptera. Table 3 show that Collembola had the high number of individuals in Agathis edge while Hymenoptera was the most numerous in Schima edge. Hymenoptera accounted for 34.19% or 1966 individuals of the arthropods collected from all four-forest habitats (Table 4). However, the Friedman’s test shows that the distribution of the number of individuals per order caught in this trap was not significant with the different forest
It means that different forest habitat does not give effect to order composition of arthropod. The abundance of understorey plants due to high light environment in the logged forest also influenced arthropod composition.

### Table 3. Total number of individuals per order of Arthropod collected from Gunung Walat Education Forest (GWEF)

| No | Order      | Agathis Edge | Agathis Interior | Schima Edge | Schima Interior | Total | Percent (%) |
|----|------------|--------------|------------------|-------------|-----------------|-------|-------------|
| 1  | Acari      | 14           | 11               | 7           | 13              | 45    | 0.78        |
| 2  | Annelida   | 1            | 0                | 1           | 0               | 2     | 0.03        |
| 3  | Araneae    | 44           | 46               | 45          | 44              | 179   | 3.11        |
| 4  | Blattaria  | 3            | 1                | 1           | 1               | 6     | 0.10        |
| 5  | Coleoptera | 51           | 68               | 78          | 87              | 284   | 4.94        |
| 6  | Collembola | 719          | 337              | 279         | 492             | 1827  | 31.77       |
| 7  | Cybacicadae| 0            | 4                | 0           | 2               | 6     | 0.10        |
| 8  | Dermaptera | 2            | 0                | 0           | 2               | 4     | 0.07        |
| 9  | Diptera    | 273          | 279              | 333         | 271             | 1156  | 20.10       |
| 10 | Gastropod  | 0            | 0                | 0           | 1               | 1     | 0.02        |
| 11 | Hemiptera  | 6            | 1                | 4           | 0               | 11    | 0.19        |
| 12 | Homoptera  | 21           | 11               | 23          | 14              | 69    | 1.20        |
| 13 | Hymenoptera| 193          | 121              | 1256        | 396             | 1966  | 34.19       |
| 14 | Isoptera   | 0            | 1                | 0           | 0               | 1     | 0.02        |
| 15 | Lepidoptera| 2            | 7                | 8           | 5               | 22    | 0.38        |
| 16 | Lithobiomorpha | 0 | 3               | 0           | 3               | 6     | 0.10        |
| 17 | Mecoptera  | 0            | 1                | 0           | 0               | 1     | 0.02        |
| 18 | Mollusca   | 1            | 0                | 1           | 0               | 2     | 0.03        |
| 19 | Opiliones  | 0            | 2                | 0           | 3               | 5     | 0.09        |
| 20 | Orthoptera | 16           | 7                | 23          | 19              | 65    | 1.13        |
| 21 | Polydesmida| 0            | 1                | 0           | 0               | 1     | 0.02        |
| 22 | Psocoptera | 27           | 12               | 16          | 16              | 71    | 1.23        |
| 23 | Thysanoptera| 5          | 7                | 5           | 3               | 20    | 0.35        |
|    | Total      | 1378         | 920              | 2080        | 1372            | 5750  | 100         |

Friedman’s test among forest habitats $X^2 = 0.152$, $p = 0.99$

### 3.3. Relationship between insectivorous birds and arthropod community

The relationship between the abundance of bird and arthropod depended on the environmental factors and forest habitat. Insectivorous birds feed mainly on arthropods; therefore, it was expected that there was a positive correlation between birds and arthropods. The results showed that there was a positive correlation between the number of bird and number of arthropods ($r=0.70$, $p<0.05$). Number of birds increased with the increase of arthropod number, and vice versa. This result was similar to study by Smith et al. [16] in coffee plantation in Kenya where bird community, especially insectivores and omnivores, were affected by arthropod community. However, they found that the number of orders or diversity of arthropod was more important than abundance in affecting bird community. A slightly different result was reported by Moorman et al. [17] who found that vegetation structure had more influence on bird abundance. McShea and Rappole [18] found that an increase in understorey density had increased the abundance of most bird species found in their study sites, while Hagar et al. [19] found that understorey vegetation support prey species for insectivorus shrub species.
4. Conclusion

Our study found that bird abundance differed between edge and interior habitat in plantation forest with edge habitat held the higher abundance. However, bird diversity did not significantly differ between those habitat types. Significant correlation was found between the number of birds, arthropods, and might be influenced by different vegetation structure.

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