Insects as food source for cattle egret (Bubulcus ibis) in Jatibarang landfill, Semarang

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Abstract. In the Jatibarang waste landfill, many cattle egrets were foraging for food insects. The objective of this paper was to identify insect (larvae and imago) and its abundance in Jatibarang waste landfill during March to May 2019. Plots (27 plots, 0.5x0.5m) were selected and insect larvae were collected beneath the wastes. Sweep net were used to sample flying (imago) insects. Population of cattle egret were estimated through counting from vantage points. There were 27 species of insects (larva and imago combined). Insect from the order of Diptera, mainly Musca domestica (houseflies) dan Chrysomya megacephala (oriental latrine fly) were dominant in the study area. Other insect found were 4 species of flies, 4 species of dragonflies, 5 species of butterflies and 2 species of grasshoppers. High diversity and density (up to 3373.33 individuals/m²) of the insects in in the garbage dump was able to support high population of cattle egrets, as many as 3365 individuals. The waste landfill can serve as an artified feeding ground for cattle egrets due the abundant larvae and imago insects.

1. Background
Cattle egret (Bubulcus ibis) is a bird species that has a wide distribution in the world, including in Indonesia [1]. Unlike other egrets, the cattle egret prefers to feed on insects than fish. This is because this species has a small stomach size [2]. Previous study revealed that food of cattle egret based on the order of the percentage is grasshoppers (66.2%), reptiles (9.7%), fish (9.3%), other insects (5.4%), spiders (3.3%), frogs (3%), plants (2.3%), small mammals (0.7%) and birds (0.1%) [3]. Cattle egrets are able to consume more varied preys, making them independent on wetlands and able to adapt on agricultural land, urban areas, and even polluted environmental conditions such as waste landfills [4].

The phenomenon of cattle egret uses waste landfill area habitat (mainly feeding ground) has been found in several cities in Indonesia, including Jatibarang waste landfill, near Semarang, Central Java. Jatibarang landfill waste management system uses open dumping. Most of the waste is a buildup of organic waste that can be visited by many species of wildlife including cattle egret [5]. A study of cattle egret in three different sites in Ghana showed that the bird looked more for food in the landfill area due.
to the existing variations of insect food, especially larvae and Diptera [6, 7]. The presence of grasses and shrubs was also an ideal habitat for insects that allows the availability of abundant feed for cattle egret.

Insects inhabited waste landfill area has not been studied previously in Indonesia. Therefore, this research was conducted to identify insects as potential food for cattle egret in a waste landfill area. The insect species presence and its number might provide a reason why the waste landfill has been served as an excellent feeding ground for cattle egrets.

2. Method

2.1. Study site

This research was conducted in March to June 2019 in Jatibarang landfill, located on Untung Surapati Street, Kedung Pane Village, Mijen District, Semarang, Central Java (7°01’28”S; 110°21’25”E) (Figure 1). The total area of the landfill is 46.02 ha with an active land for open dumping waste management covering an area of 23.4 ha. The landfill is situated on the hilly to high steep land, with an elevation between 75-195 m asl. The site is also adjacent to the upstream area of the Kreo River which flows into Kaligarang River [8]. The amount of waste that enters the Jatibarang landfill reaches approximately 800-900 tons/day with a composition of 62% organic material and 38% inorganic waste [8].

A huge population of cattle (cows) owned by local residents was also can be found in the landfill. Initially, the Department of Sanitation and City Parks gave donations of 20 cows for trials to reduce waste. After several years, the population grows and reaching about 2,000 cows [9].

The research area was divided into 3 zones. Active Zone 1 is an area for new garbage disposal collecting from urban areas, mostly organic waste. The waste entering the landfill site every day will be immediately discharged to this Active Zone 1. Active Zone 2 is a site for old-aged disposal and has rubbish that is already decomposed and naturally dried. The third zone, the Active Zone 3 is a waste disposal area that has been no longer in use due to its susceptibility to landslide. Waste in this zone was much more older and mostly decomposed.
Figure 1. Map of study site in Jatibarang landfill area, Semarang, Central Java

2.2. Data collection and analysis
Nine plots of 50x50 cm was purposively selected to collect insects in the Active Zone 1, 2, and 3, totalling 27 plots. On each selected plot, samples of garbage and soil to the depth of 5 cm were dug, assuming that cattle egret is able to peck for food as deep as 5 cm. Insects larvae and imago were separated from the rest of the waste. The insects found were counted and identified. Due to the difficulties in identifying the insect, the identification was conducted up to family level.

Imago collection was supplemented by sweep net method, to sample flying insects. Samples were taken twice a day, 7-9 am and 3-5 pm, following the insects’ peak activity to avoid bias [10]. Three 500 m line transects (one transect for each zone) were placed purposively in the most abundant of cattle egrets in each zone. Population of cattle egret were estimated through counting from vantage points at the maximum number, between 6-9 am.

Data on insect species and its abundance were quantified by using Shannon-Wiener diversity indices (H’) [11]. Chi-square test [12] was used to detect whether there was a preference in the insect media/habitat in the waste landfill.

3. Results
Twenty three insects species of seven order (larvae and imago combined) were found in the study sites, all are potential food for cattle egret (Table 1). The insects basically can be categorized as flies (Diptera), which constituted almost all samples, and beetles (Coleoptera). In the larval phase of Diptera, it was very difficult to classify to family due to the very similar morphology of the samples, although most likely they were originated from two species of flies, namely Musca domestica (housefly) and Chrysomya megacephala (oriental latrine fly) (Figure 2).
Clearly the distribution of insects across the three zones varied widely, with the Active Zone 1 (fresh waste area) significantly having the most abundant insect in terms of number and density \( \chi^2 = 12554.24, \text{ df } 2, p<0.001 \), dominated by *Musca domestica* and *Chrysomya megacephala*, both were Diptera. The species diversity, however, was very low due to the dominance of these two species.

In the Active Zone 2 (partly decomposed waste area), no Dipteran imago was found. In this zone, Orthoptera (grasshoppers), Lepidoptera (butterflies), and Odonata (dragonflies) were dominant. In the Active Zone 3, the dominant species was earwig (order Dermaptera). Some member of the family of Diptera can also be found in the Active Zone 3, but the families differed compared with the Dipteran found in the Active Zone 1. Although the Active Zone 3 has the lowest number of individuals and density, the species diversity reached the highest among the three zones \( H' = 1.075 \).

Estimation of cattle egrets number revealed that there were 3365 birds visited all three zones. Assuming that the coverage was similar, chi-square test suggested that there was a preference by the birds on the zones they visited to forage \( \chi^2 = 1592.74, \text{ df } 2, p<0.001 \). Active Zone 1 obviously preferred by the cattle egrets.

### Table 1. List of potential insect food for cattle egret in Jatibarang landfill

| No | Order       | Family           | Species                  | Active Zone 1 | Active Zone 2 | Active Zone 3 | All Zones |
|----|-------------|------------------|--------------------------|---------------|---------------|---------------|-----------|
| 1  | Diptera     | Unidentified     | Unidentified             | 5208          | 531           | 84            | 5823      |
| 2  | Coleoptera  | Unidentified     | Unidentified             | 1             | 1             | 1             | 1         |
| 3  | Diptera     | Muscidae         | *Musca domestica*        | 2024          | -             | -             | 2024      |
| 4  | Diptera     | Calliphoridae    | *Chrysomya megacephala*  | 357           | -             | -             | 357       |
| 5  | Coleoptera  | Stratiomydidae   | *Hermetia illucens*      | -             | 6             | 6             | 6         |
| 6  | Diptera     | Deliochopodidae  | *Chrysosoma sp.*         | -             | -             | 6             | 6         |
| 7  | Coleoptera  | Unidentified     | Red Flies                | -             | -             | 2             | 2         |
| 8  | Coleoptera  | Syrphidae        | *Eristalinus megacephala*| -             | -             | 2             | 2         |
| 9  | Dermaptera  | Unidentified     | Earwig                   | -             | 79            | 79            | 79        |
| 10 | Orthoptera  | Acrididae        | *Valanga nigricoris*     | -             | 2             | -             | 2         |
| 11 | Orthoptera  | Pygromorphidae   | *Atractomorpha sp.*      | -             | 2             | -             | 2         |
| 12 | Lepidoptera | Pieridae         | *Eurema blanda*          | -             | 1             | 1             | 1         |
| 13 | Lepidoptera | Pieridae         | *Catopsilia pomona*      | -             | 1             | -             | 1         |
| 14 | Lepidoptera | Pieridae         | *Leptosia nina*          | -             | 1             | -             | 1         |
| 15 | Lepidoptera | Nymphalidae      | *Acraea violae*          | -             | 1             | -             | 1         |
| 16 | Lepidoptera | Nymphalidae      | *Danaus chrysippus*      | -             | 1             | -             | 1         |
| 17 | Lepidoptera | Nymphalidae      | *Hypolimnas bolina*      | -             | 1             | -             | 1         |
| 18 | Odonata     | Libellulidae     | *Orthetrum sabina*       | -             | 1             | 1             | 1         |
| 19 | Odonata     | Libellulidae     | *Macrodiplax cora*       | -             | 1             | -             | 1         |
| 20 | Odonata     | Libellulidae     | *Pantala flavescens*     | -             | 10            | -             | 1         |
| 21 | Odonata     | Coenagrionidae   | *Ischnura senegalensis*  | -             | 2             | -             | 2         |
| 22 | Hymenoptera | Apyae            | *Apis sp.*               | -             | 1             | -             | 1         |
| 23 | Hemiptera   | Unidentified     | Assassin bug             | -             | 1             | -             | 1         |

Number of individuals 7590 556 180 8326
Density (individual/m²) 3373.33 247.11 80.00 137.05
Number of species (imago only) 2 1 1 4
Diversity index (H') 0.755 0.281 1.072 2.108
Number of cattle egrets 2213 578 574 3365
Figure 2. Insect species found in the landfill waste area
4. Discussion

During the field observation, unfortunately feeding behaviour of the cattle egret could not be conducted, and thus the insect species actually eaten by the cattle egret remained unknown. However, it was clear that the cattle egret preferred waste landfill as feeding areas. The occurrence of big population of the cattle egret in the study area showed that the food availability was able to reduce inter-specific competition [6], due to the ease of finding of food, as well as minimize energy to find food [13, 14].

Studies in other areas revealed that cattle egret consumed Diptera (flies), Orthoptera (grasshoppers), Lepidoptera (butterflies), Odonata (dragonflies), Hymenoptera (bees) and Dermaptera (earwig) [2, 11], similar to this study when all zones were combined. In this study, Coleoptera (beetles) and Hemiptera (true bugs) were also present, although their number was low.

Active Zone 1 had the highest population density because there was a continuous garbage disposal every day, thus able to provide a continuous organic waste as food and habitat for the larvae, mostly Musca domestica. These flies preferred a damp habitat with a strong odour [15]. The presence of abundant cattle dung in this zone also provided media for breeding of Musca domestica [16]. This species has a high reproductive ability because it can produce 2,000 offspring, equivalent to 12-13 generations per year [17]. As for Chrysomya megacephala, the reproductive capability is not as high as Musca domestica. In addition, this species needs to lay eggs on carcasses [18], which was a bit lacking in the Active Zone 1. Other insect (imago phase) was lacking due to the disturbance from three sources: (a) people who collect some waste to be recycled, (b) the activities of excavators by employee for waste processing, and (c) cattle that feed on organic waste.

Active Zone 2 had a moderate population of insect, but the diversity index was the highest. This is due to the absence of species that dominating the community [13]. In this zone, the Pantala flavescens (globe skimmer), the most common dragonfly worldwide, were quite dominant in the Active Zone 3, Musca domestica and Chrysomya megacephala were not found, most probably due to the lack of odour from the dried waste, and thus less attracted for these two species. This condition, however, was suitable for Hermetia illucens, whose pre-pupa phase requires a dry place to develop until the pupa stage [14]. There were also Chrysosoma sp., a carnivorous insect that prey on smaller insects [19]. In addition, there were some wild flowers nearby, which affected the presence of Eristalinus megacephala due to its pollen and nectar. Earwig in this zone also a potential food for the cattle egret. The insect species in this zone could be more abundant, considering that many of the insects were nocturnal.

5. Conclusion

Jatibarang waste landfill is able to serve as an artificial feeding ground for cattle egrets. In the study area, 7 order of insects were found, including the larvae of Diptera and Coleoptera, as well as the imago of Diptera (flies), Orthoptera (grasshoppers), Lepidoptera (butterflies), Odonata (dragonflies), Hymenoptera (bees), Dermaptera (earwig), Coleoptera (beetles) and Hemiptera (true bugs). All of these are potential food for cattle egret.

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