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ORIGINAL ARTICLE

VARIATION IN PREY COMMUNITY DETERMINES NESTING RATES OF *MEROPS PHILIPPINUS*

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Abstract: *Merops philippinus builds its nests by digging holes in river cliffs. Some of the nesting sites experience successful reproduction with variable nesting rates. The determinant of such variation is unknown. Noachhar, Sadhugunj, and Dinhata are such three successful nesting sites with drastically different nesting rates. This study explores the composition of the prey community of Merops philippinus that may determine the nesting rates of this bird in these three sites. Statistical analysis of field data reveals that low Bee and Wasp, but high Damselfly, Homopteran, and Ants make up the prey community to observe high nesting at a successful site.*

Keywords: Prey community, variation, nesting rate, *Merops philippinus*.

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1. INTRODUCTION

Merops philippinus is a long-distance migratory bird in the southeast of Asia [1]. They come to the breeding zone in India, Bangladesh, Pakistan, and China during March and April [2]. There they build their nests by digging holes in the river cliffs. Their nesting sites are distributed in patches within the breeding zone [3, 4]. In some nesting sites, the nests are maintained by birds; in other sites, the birds abandon the nests [5]. The sites where birds live, reproduce and raise their offspring after nesting is called successful nesting sites [1,3, 6]. A successful nesting site does not ensure a large colony [7, 8]. The colony size often varies from site to site despite successful nesting due to different nesting rates. Some successful nesting sites have larger colonies of these birds, where the nesting rates, i.e., the number of nests per unit area, are very high. Some successful nesting sites, on the other hand, have smaller colonies. In this latter case, the nesting rate is low.

Existing literature explores ecological conditions of nesting success among sites, but the same for the nesting rates are yet unknown. Yuan *et al*. [8] suggested that these birds prefer silty loam with diverse insect communities. Ghosh *et al*. [3] suggested clay content, sand content, magnesium, carbon, nitrogen, iron, and pH of neo-alluvial soil determine the success rates of nesting and reproduction of these birds. The work also finds that the abundance of Dragonfly, Damselfly, Lepidopterans, Bees, Wasps, and Ants are associated with the success probability of nesting and reproduction. The soil properties of all successful nesting sites stay approximately the same since the nesting soils are primarily of neo-alluvial types in all successful nesting sites. However, the prey community may vary in these sites due to the presence of other insectivore birds [9. 10]. Two different successful sites may have different abundances of other insectivore birds.

Therefore, the predation of insects varies in different successful nesting sites, resulting in variability of prey abundance for the concerned species.

Different insect species possess different nutrient values for the birds [11]. Thus, the energy production from the consumption of these insects is also highly variable [12, 13]. Availability of some insects that contribute to nesting success, may also promote nesting rate. A high abundance of an insect reduces the prey searching time, reducing the energy cost of predation [14]. As a result, an abundant nutrient-deficient prey insect may also influence the nesting rate. Also, each predator has a preferred prey species. *Merops philippinus* is no exception. Although it belongs to the bee-eater family, existing literature indicates their prey preference lies more in dragonflies, damselflies, and lepidopterans. While lepidopterans are strongly associated with their reproduction, dragonflies and damselflies are known to be preferred throughout the years.

Therefore, inspecting the variation in prey insect communities of three successful nesting sites with three different nesting rates of this bird is important to understand the variability in their nesting mechanism. This study revisits the datasets of three successful nesting sites of Ghosh et al. [3] and investigates the effects of food diversity on nesting rates.

2. METHODOLOGY

Three successful nesting sites were identified based on the nesting rates in the metadata of Ghosh *et al*. [3]. The sites are Noachhar in Burdwan, Sadhugunj in Nadia, and Dinhata in Jalpaiguri, West Bengal. Noachhar had the highest nesting rate (>100 nests per colony), Sadhugunj had a moderate nesting rate (75-100 nests per colony), and Dinhata had the lowest nesting rate (<75 nests per colony) in 2019-2020. Insect pellets, i.e., the vomited and compressed insect exoskeletons by birds, were collected, dissected, and identified. Only intact or large exoskeletons were identified in the process; smaller fragmented exoskeletons were filtered out in order to reduce uncertainty.

The final data set contained data points of 100 pellets for each of the sites. The biases in the dataset that might have arisen with filtering out fragmented exoskeletons are expected to be canceled out by the large data size. Variation in prey abundances between sites are captured in the frequency data of preys within pellets. Such a variation may be observed over time within a site too. However, this study focuses on the variation between sites, so we clustered pellets over different time points of the breeding season into one per each site.

Welch's ANOVA was performed for each insect found in the pellets, and Welch's F is estimated to check the variance of the insect abundance to avoid the effect of unequal variances over sites. ω_p^2 were estimated to check the effect sizes or associations between the insect abundance among sites. Sidak-Holms' adjusted p-values were estimated from the test to check the degree of the differences if there is a significant difference between the distributions of prey abundance among three sites. Lower the adjusted p-value is, the sites have more different distributions of a prey.

3. RESULT AND DISCUSSION

Dragonfly abundance were highest in Noachhar, moderate in Sadhugunj, and Lowest in Dinhata. The variance of Dragonfly abundance over three sites is insignificant, as shown in Figure 1. Therefore, Dragonfly abundance do not contribute to nesting rates. Note that Dragonfly abundance is correlated to nesting success as per Ghosh *et al*. [3].

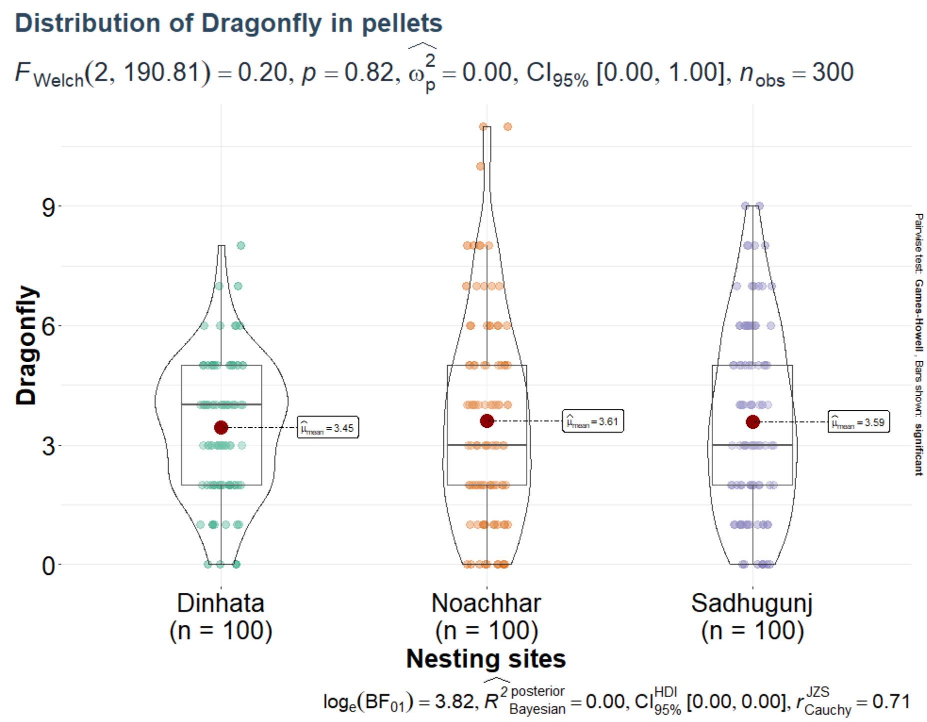

Figure 1: Statistical analysis of Dragonfly over three survey sites

These three sites were all successful sites with various nesting rates. Hence, Dragonflies may be an indicator of nesting success but not the nesting rate.

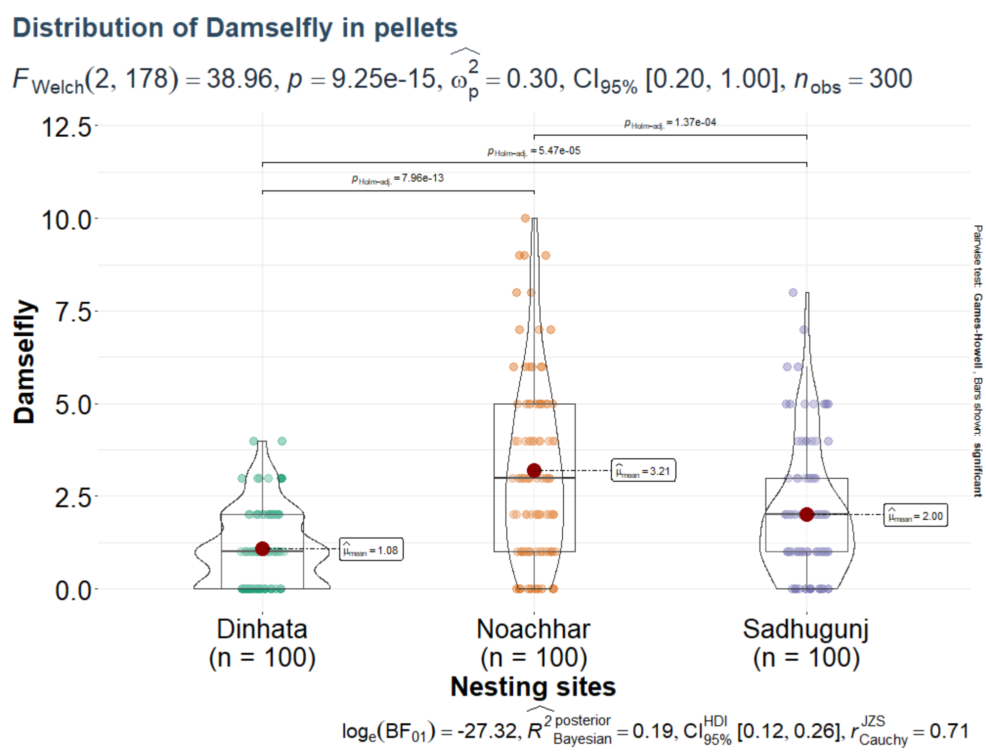

Figure 2: Statistical analysis of Damselfly over three survey sites

Damselfly abundance and their variance were significantly different between all three sites (Figure 2). Noachhar had the highest abundance, and Sadhugunj had the lowest of it. Therefore, Damselfly maybe a good predictor of nesting rate of *Merops philippinus*.The adjusted p-values suggest that Noachhar and Dinhata have most different Damselfly abundance distributions that had contributed to the difference between highest and lowest nesting rates.

Homopteran abundance and its variance differ significantly with highest nesting site Noachhar than the moderate nesting site Sadhugunj and lowest nesting site Dinhata. However, the difference in the Hompteran abundance distribution between Dinhata and Sadhugunj is insignificant (Figure 3). So homopteran abundance may contribute to raise the nesting rate from moderate to highest but it can not elevate nesting rate from lowest to moderate.

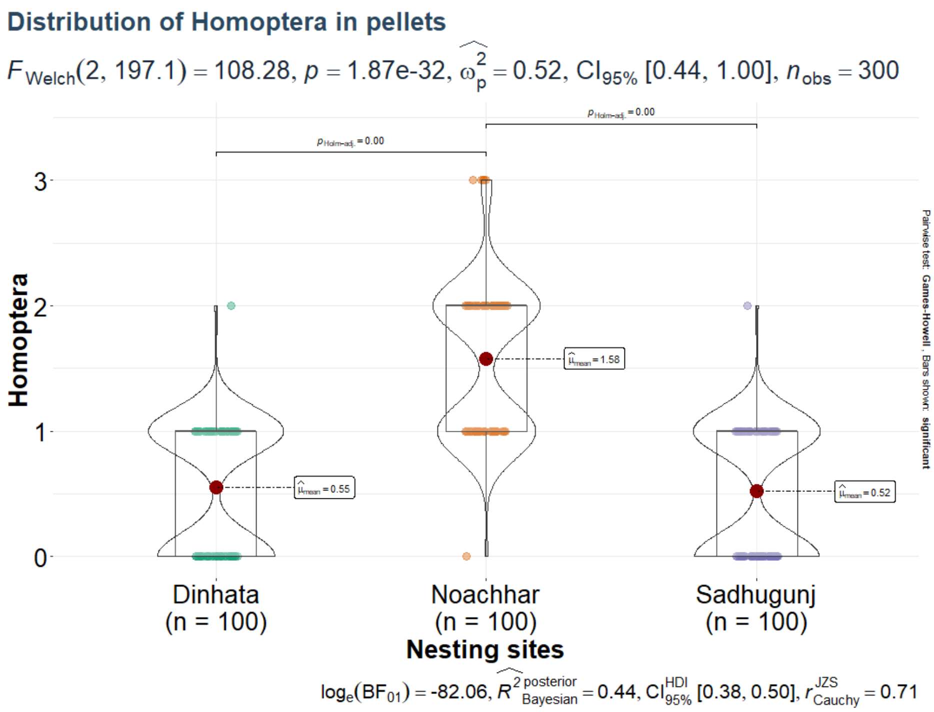

Figure 3: Statistical analysis of Homopterans over three survey sites

Bee abundance and their variance are significantly different in moderate nesting site Sadhugunj, than lowest nesting site Dinhata and highest nesting site Noachhar (Figure 4). However, there is no significant variance between the bee abundance distribution of Dinhata and Noachhar. This result suggests that abundant bee may reduce the nesting rate from highest to moderate, and moderate to lowest, but the mean number of bees in the prey vary insignificantly between highest and lowest nesting rates. So, scarcity of bee in a site drops the nesting rate to moderate one from highest but a recovered bee abundance drops the nesting rate to lowest instead of increasing. One possible explanation is that bees are the easy catch for bee-eaters making a significant large part of their diet, but provides lower energy and nutrients than other preys such as Damselfly. Therefore, the drop in their abundance is compensated by the more energy providing preys. However, upon their increased abundance, birds consume other necessary prey in a less amount cutting their energy to dig nests.

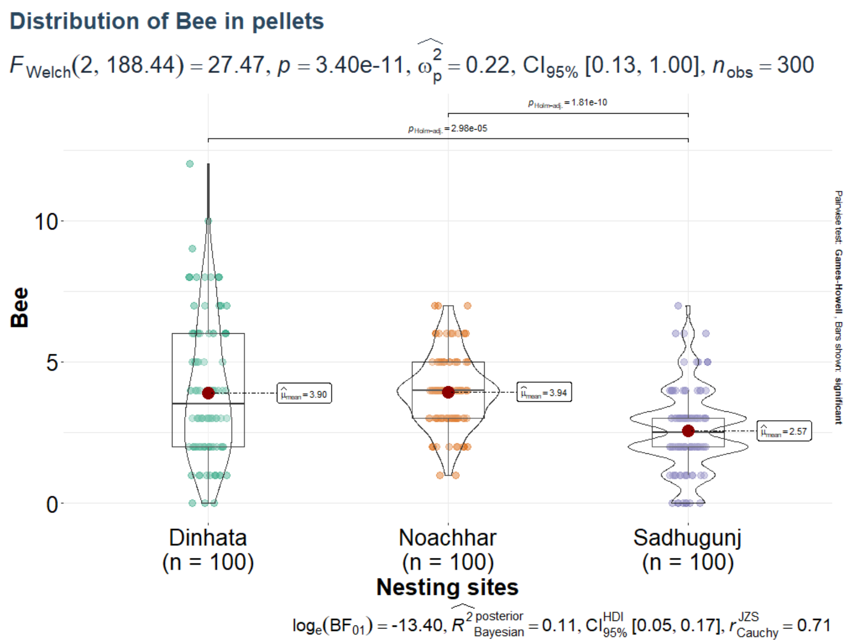

Figure 4: Statistical analysis of Homopterans over three surveyed sites

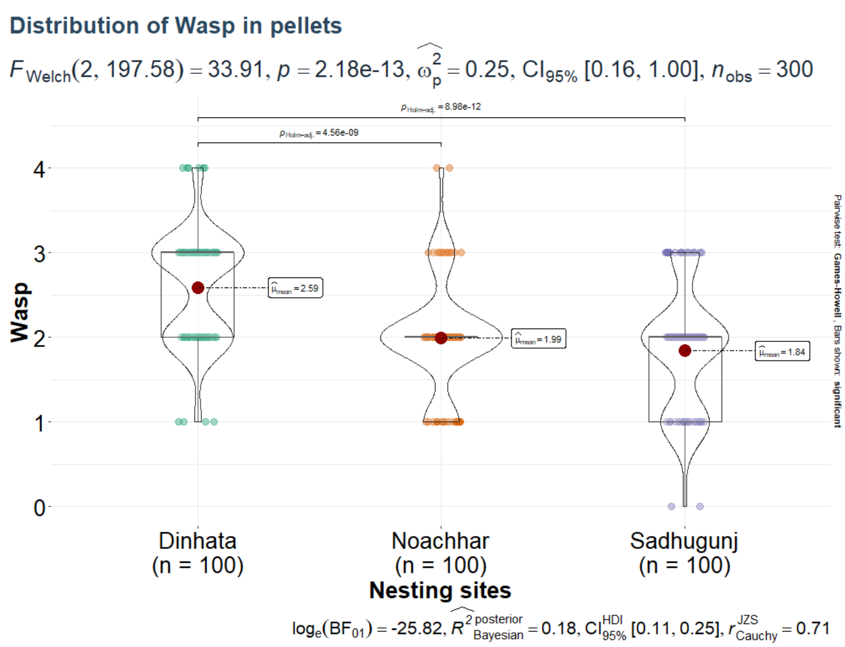

Figure 5: Statistical analysis of Homopterans over three surveyed sites

Figure 5 suggests that Wasp abundance and its variance differs significantly for the Dinhata from Noachhar and Sadhugunj. However, there is insignificant difference in their distribution between Noachhar and Sadhugunj. The wasp abundance is highest for the lowest nesting rate and highest for the lowest nesting rate. Abundant wasp increases the nesting rate from moderate to highest but further increase drops the nesting rate to the lowest. It may be possible that the poor nutrient value and the higher catchability of wasps is responsible for the lower nesting rate. Therefore, wasp abundance is a predictor of lower nesting rate at a given site.

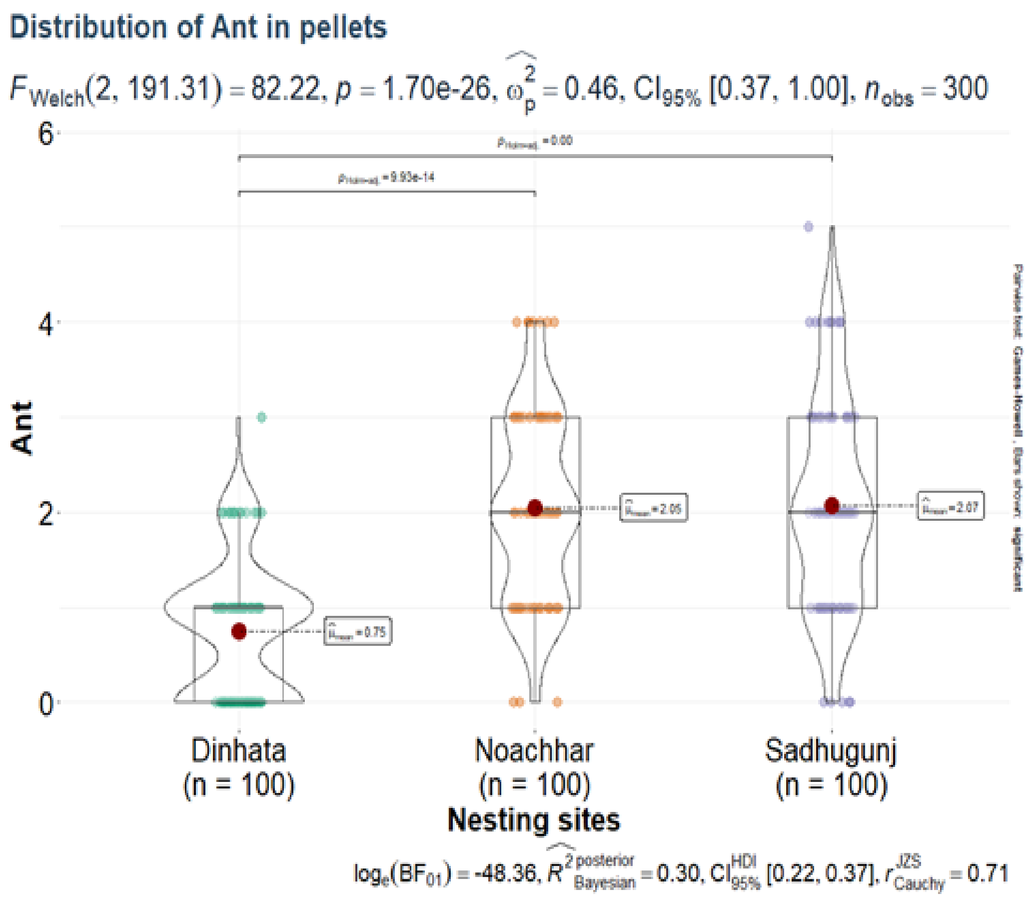

Figure 6: Statistical analysis of ants over three survey sites

Ants are another easy catch of *Merops philippinus* during nesting that differs significantly in Dinhata than Noachhar and Sadhugunj. Noacchar and Sadhugunj, however, do not differ significantly in terms of Ant abundance distribution. Ant abundance increases with the nesting rates as per the Figure 6. This result suggests that ants are predictor of moderate to high nesting rates. One possible explanation of such a finding is that Ants rich soils are preferred by this bird. Birds generally eat ants, while digging their nests in soil. Presence of ants may increase the porosity of the soil, making it easy to dig, finally increasing nesting rate.

4. CONCLUSION

Different abundant preys contribute to nesting rate of *Merops philippinus* differently. Dragonflies are abundant in all successful sites with various nesting rates confirming its crucial relation to nesting success but no role in determining nesting rate of *Merops philippinus*. Presence of Damselfly and ants increases the nesting rates at all sites, but Homopteran presence can increase nesting rate only sites with moderate nesting rate. Bees and wasps are abundant prey but they might be less preferred food during nesting. The strong association between this bird's nesting and odonata diversity of Ghosh et al. [3] and Yuan et. al. [8], indicate that the odonates might be preferred prey of this bird. A bird may need more prey search and catching time for their preferred odonates, if bees and wasps have greater abundance than odonates. The higher prey searching and catching time yet catching energy deficient preys, may reduce the nesting rate, as a consequence.

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