BIOMONITORING OF HEAVY METALS IN THE YELLOW-BILLED BABBLER IN SELECTED LANDSCAPES IN SRI LANKA FROM A CONSERVATION PERSPECTIVE

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INTRODUCTION

Urbanization is one of the most important global change processes. One paramount challenge for environmentalists is to determine how specific features of the urban environment influence the city inhabitants, of which humans are also a part. Sri Lanka is an island that, exhibits remarkable biological diversity and is considered to be one of the hotspots for biodiversity in the region. Since Sri Lanka has been going through a phase of industrialization and rapid urbanization over the last four decades, there has been a trend of an increased release of pollutants into the air, water, and land, resulting in serious environmental problems (Ileperuma, 2000).

A variety of biomonitoring tools to assess toxic metals have been used in the recent decades; out of them, birds as bio monitors are significant as they inhabit the higher levels of the food pyramid, are visible and conspicuous, have a comparatively long lifespan, and have pathologies and population levels that are measurable (Burger & Gochfeld, 2000). In this regard, we selected a widely distributed bird species that is one of the most common members of the babbler group found in Sri Lanka called the *Turdoides affinis* (yellow billed babbler).

This study is extremely important as it establishes a scientific basis for a biomonitoring program. This will be immensely helpful for the long-term biomonitoring for wildlife conservation. The effects of pollutant exposure to wildlife can be investigated through this study, which can be integrated with planning strategies for wildlife conservation. The wildlife conservation and management system of the country depends on scientific data, but there are no any studies that have been conducted so far to cover different climatic and ecological zones in the country. Further, there is no evidence that consider the effects of the exposure of terrestrial birds to toxic pollutants island wide in Sri Lanka. Therefore, the data generated by this study will be used for wildlife conservation in the country.

The biomonitoring process used in this study indicates toxicological pollution in the environment. It also examines the levels of toxicological exposure in different parts of the country, especially based on birds as the indicator organism. This creates a useful platform for the identification of the consequences of pesticides and heavy metal pollution, and thereby will be immensely helpful for the conservation of natural systems, as well as their organisms, for a sustainable future.

Aims and objectives of the study

The main aim of this study was to identify the toxic metal levels in feathers of Yellow- billed babblers and how they varied in different habitats based on urbanization.

The objectives of this study were to -
determine the exposure of birds to heavy metals in urban, semi-urban, and forest landscapes in Sri Lanka,
whether there is a relationship between environmental contaminants/ habitat type in birds and their blood physiology, and
whether there is a relationship between environmental contaminants in birds and their aggressive behavior.

METHODOLOGY

This study was designed to investigate heavy metal pollutants through the analysis of bird feathers. Accordingly, three sites of different levels of urbanization were selected: an urbanized area, a semi-urbanized area, and a forest area. To fulfill these objectives, six birds from each site were captured using standard mist netting techniques (Smith et al., 1999) to acquire tissues to analyze for toxic metals. From the captured birds, blood was drawn in capillary tubes according to Owen (2016), standard phylogenetic traits were recorded, and two tail feathers were removed from three randomly selected birds.

The collected feathers were stored in envelope and sent for heavy metal analysis. Approximately 0.5g of feathers were prepared for heavy metal analysis following the method of Gushit et al. (2016). Thereby, they were tested for Cadmium (Cd), Lead (Pb), and Arsenic (As) using the Zeeman Atomic Absorbent Spectrophotometer with a graphite tube atomizer (Varian AA 240 FS). Further samples were tested for Mercury (Hg) using a Cold Vapor Atomic Absorbance Spectrophotometer (Varian VGA-77). Along with this analysis, various blood parameters, including; blood cell counts, the Packed Cell Volume (PCV), and hemoglobin (Hb) concentration were measured by referring to the works of Elarabany (2018) and Chung et al.(2015). From the obtained values, blood indices were calculated. All collected data were statistically analyzed using IBM SPSS (version 20).

RESULTS AND DISCUSSION

Analysis of morphology and plumage

The analysis was conducted by carrying out a Principal Component Analysis (PCA). In the morphology-based PCA, PC1 explained 36.5% of variation and described no size differences between the species in different habitat types, while in the plumage PCA, PC1 captured 56.3% of variation, correlating well with all the characters that tend to differ between habitat types ($P < 0.001$) (Figure 1).

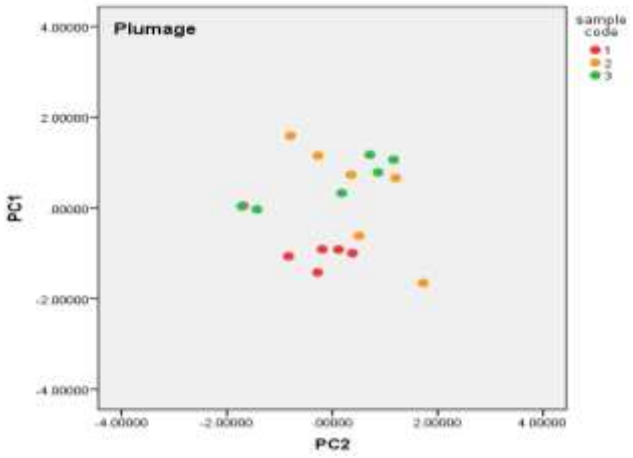

Figure 1 – Variation of the plumage characteristics of the yellow billed babbler which inhabit urban, semi-urban and natural habitat types.

Analysis of heavy metals –

To analyze heavy metal accumulation, a one-way Analysis of Variance (ANOVA) was performed. Pb was slightly higher in the urban habitat (0.07 ppm) compared to the other locations, while the concentrations of Cd (0.31 ppm) and Hg (0.50 ppm) were slightly higher

in the natural habitats. The concentrations of the metals were not statistically significant ($p > 0.05$).

Analysis of blood parameters

To analyze the blood parameters, a one-way ANOVA was performed. It was found that the Red Blood Cell (RBC) count, PCV, and Hb were statistically significant ($P < 0.05$). We also observed that the basophil and monocyte percentages were zero in the natural habitat. However, there was a sharp rise in the eosinophil percentage in the semi-urban habitat with a steep drop in the heterophil percentage in the urban habitat. Of the blood indices calculated, the value obtained for MCV and MCH was negligible in all three study sites, but the values of MCHC ranged between 42.65 - 24.39 in the different habitats.

Analysis of aggressive behavior

Aggression scores were interpreted by finding the percentage of the aggression scores. We observed that the aggression expressed by the birds in the urban habitat was high, while non-aggression expressed by birds was highest in the natural habitat (Figure 2). It was also observed that the percentages obtained in the semi-urban habitat were strikingly similar.

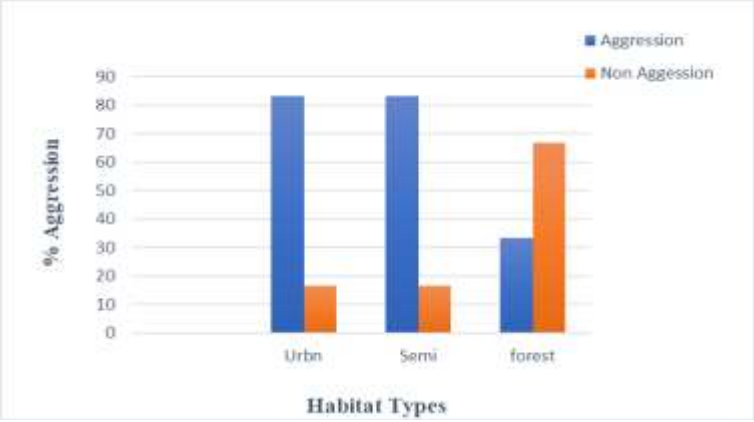

Figure 2 - Comparison of percentages of aggressiveness in adult Yellow billed babblers that inhabit urban, semi-urban and natural habitat types.

The overall results from the present study showed that there were no significant variations in toxic metal levels, blood parameters, or morphological traits., However, there were variations in plumage characteristics and the aggressive behavior of the birds. One major finding was that toxic metals were detected in all study sites. Pb was reported higher in the urban environment, which could be because of vehicular emissions. The high levels of Hg in the natural habitat could be, possibly due to birds feeding in the paddy field where pesticides containing Hg are used. However, the levels detected were below the threshold for adverse effects. On the other hand, Cd was reported to be higher in the natural and semi-urban habitat. These high levels are susceptible due to the surrounding tea factories where Cd is a toxic waste metal. Although the detected levels were above the threshold to cause adverse effects, there was no effect detected in the birds. Having said that, when the plumage characteristics were analyzed by PCA, there were considerable differences in the habitats. In their study on carotenoid coloration, Geens et al ., (2009) state that P. major exposed to Pb had paler plumage. A convincing explanation for this can be that feathers are exposed to exogenous contamination. Another key objective of the study was to determine the effect of toxic metals on the aggressive behavior of birds. Pb was detected to be in the highest concentration in the urban environment. The presence of Pb can be perilous as exposure to Pb has been reflected on the cognitive behavioral traits such as birdsong, and the physiological and neurological

systems, potentially reflecting neurotoxic effects on fearfulness. (Janssens et al., 2003). Moreover, many others studies evidence that the presence Pb is responsible for the heightened aggressive behavior.

However, it should be noted that the toxic metal concentration in the present study is low in comparison to many other similar studies. This may indicate low levels of metal pollution. The differences in toxic metal levels observed in the different studies in various habitats could be due to the fluctuations in the levels of environmental contamination and the size of the selected study sites. Moreover, feathers are a good biomonitoring matrix although they only represent the body burden at the time of feather growth. Further, metal contaminations could vary within and between feather types, and therefore, demand the need for multiple feathers to be removed. This would thus lead to being a destructive biomonitoring tool. Moreover, the results for heavy metals were collected from only three birds, which is not large enough to generalize the result. Therefore, it may not reflect the actual accumulations of the habitats. A larger sample size may have yielded better results.

CONCLUSIONS/RECOMMENDATIONS

It was concluded that heavy metals accumulated in all three habitats despite the sample size and urbanization. also, there were notable discrepancies in blood and plumage characteristics while the morphometric traits remained unchanged. regardless, there was a clear difference in aggressive behavior in relation to heavy metal accumulation.

Based on this study, it is recommended that remedial action against the release of toxic metals needs to be taken for the conservation of the environment. Thereby, stress levels due to aggressive behavior in the bird species can be curtailed, by initiating conservation studies.

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