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Effects of Anthropogenic Habitat on Plasma Biochemistry of Urban-Breeding Ring-Billed Gulls

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Abstract

Gulls (Larids) have mastered the art of foraging in human-created areas. However, little is known about the health effects of using anthropogenic habitats and the exposure to environmental pollutants that comes with it. This is especially true when it comes to plasma biochemistry, which is frequently used to diagnose physiological disorders and diseases. The plasma biochemistry of urban-breeding ring-billed gulls (Larus delawarensis) from one of the largest North American colonies was the subject of this study, which sought to investigate the effects of anthropogenic habitat use and exposure to ubiquitous halogenated flame retardants (HFRs). Individual gulls' foraging habitat use was characterized using miniature GPS dataloggers (n = 39) in the Montreal area (QC, Canada) at the regional scale (urban, waste management facilities, agricultural fields, and St. Lawrence River), and plasma was analyzed for a suite of biochemical measures (waste products, lipids, glucose, ions, proteins, and enzymes) and HFRs. Sex, body condition, the amount of time spent fasting while incubating, plasma thyroid hormone levels, the time of day, the capture date, and the ambient temperature were all evaluated as potential confounding biological and environmental variables.

Keywords: Polybrominated diphenyl ethers; Dechlorane plus; Clinical chemistry

Introduction

Plasma HFR concentrations were only significantly correlated positively with aspartate aminotransferase activity (PBDEs and dechlorane-related compounds). Certain plasma biochemical measures were significantly correlated with time spent fasting while incubating, plasma thyroid hormone levels, body condition, time of day, and capture date. The plasma biochemistry of ring-billed gulls breeding in the densely populated Montreal area may be affected by both the use of anthropogenic habitats for foraging and exposure to HFRs, suggesting potential adverse health effects for avian wildlife living in highly urbanized environments. Gulls (Larids) are a group of birds that have adapted to using food resources in habitats that have been altered by humans all over the world. They are opportunistic generalists who are able to eat a wide variety of food (human waste) found in urban environments. As a result, they have caused population explosions in several areas where such food is plentiful and easily accessible [1-3]. However, little is known about the physiological effects of using this stressful environment, and birds that breed or live in urbanized areas may also experience a number of stressors like human disturbance, light and noise pollution, poor diet, and environmental contaminants.

The most common Larid in Canada is the ring-billed gull, has emerged as a useful bioindicator species for examining how anthropogenic factors affect birds [4]. Breeding individuals from this population were found to prefer urban, agricultural, or waste management facility habitats for foraging in the densely populated Montreal area (QC, Canada). Montreal-breeding ring-billed gulls were found to primarily eat human waste when foraging in urban areas and waste management facilities (like landfills and wastewater treatment plant basins, for example). Although these high-energy foods are exploited and the consequent decrease in the number of gastrointestinal parasites may provide ring-billed gulls with ecologically relevant advantages, but there are also potential drawbacks. Specifically, male ring-billed gulls had plasma concentrations of the deca-BDE mixture (containing more than 97% BDE-209) that were higher the more time they spent in waste management facilities. However, found no correlation between plasma HFR concentrations and the ring-billed gulls' use of urban habitat (such as the city) or agricultural fields in this colony. In addition to various additional contaminants like organochlorines. It has also been demonstrated that ring-billed gulls from this colony accumulate a number of trace elements linked to human activities. For instance, it was discovered that male gull liver concentrations of lead (Pb) were significantly higher when landfills and wastewater treatment plant basins were used more frequently. Additionally, exposure to selenium (Se), cadmium (Cd), and the rare earth element yttrium (Y) increased when gulls spent more time foraging in agricultural fields.

In Montreal-breeding ring-billed gulls, exposure to environmental contaminants has been linked to a number of potentially harmful physiological effects [5-7]. Thyroid-related gene transcription and plasma levels of thyroid hormone have been linked to liver concentrations of endocrine disrupting PBDEs, PCBs, and/or chlordanes, and the activity of hepatic deiodinase. Additionally, spleen mass, an indicator of immune activity, was positively correlated with PBDE and/or PCB concentrations and ring-billed gulls' field metabolic rate, indicating that this exposure may result in an energetic cost. Moreover, a few PBDE congeners were adversely connected with bone (bone structure) mineral thickness, which showed demineralization of the bone framework possibly intervened through HFR openness.

A well-established method for examining physiological disorders and identifying diseases in animals, including birds, is assessment of plasma biochemistry [8]. However, this can also be used to investigate

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the potential physiological effects of a variety of stressors on wildlife, such as environmental contaminants (For instance, the status of the kidneys and liver has been evaluated using plasma biochemical measures, energetic metabolism and bone metabolism (such as levels of alkaline phosphatase, calcium, and phosphorus. However, there are very few studies on the relationship between anthropogenic stressors and plasma biochemistry in wild birds. However, some plasma biochemical measures, such as glucose, cholesterol, uric acid, urea, creatinine, and sodium levels, as well as the activity of alanine aminotransferase, have been shown to correlate with concentrations of several HFRs and organochlorines in raptor nestlings (of several species) and adult great skuas (Stercorarius skua) breeding in northern Europe.

Model selection was used to further evaluate plasma biochemical measures that were significantly related to anthropogenic habitat use or HFRs. This allowed us to determine which variables—or combinations of variables—best explained the variations in plasma biochemistry. For each biochemical measure, a series of Generalized Linear Models (GLZs) were used to rank them, and the Akaike's Information Criterion (AICC) was used to adjust for small sample sizes. In the models, the effects of plasma HFR concentrations and the amount of time spent foraging in various habitats on plasma biochemistry were evaluated to determine whether they had separate or combined effects. The models also tested confounding variables like the capture date, time of day, egg laying date, ambient air temperature, body condition, thyroid hormone levels, and time fasting on the nest that could affect plasma biochemistry.

Discussion

In veterinary medicine, plasma biochemistry is frequently used as a diagnostic tool because levels below or above reference values can indicate physiological disorders or diseases in animals. Plasma biochemistry can be helpful for understanding the potential effects of anthropogenic stressors, such as contaminant exposure, in correlative studies of wildlife species. The present study found that urban or agricultural habitat use and/or HFR exposure correlated with a number of plasma biochemical measures (cholesterol, albumin, and phosphorus, as well as the activity of alkaline phosphatase and aspartate aminotransferase) in ring-billed gulls breeding in the highly urbanized Montreal area [9-10]. This suggests that these factors may affect physiological processes that in turn may affect the plasma biochemistry of ring-billed gulls. However, there was no statistically significant interaction between plasma HFR concentrations and habitat use variables in any of the models.

Conclusion

The use of urban or agricultural habitats for foraging by ring-billed gulls and their exposure to HFRs were linked to a number of plasma biochemical measures. We propose a number of hypotheses based on this that may point to health or physiological implications associated with the preferential foraging use of these anthropogenic habitats. First, we suggest that consumption of human waste from landfills and urban areas, which typically contain a lot of fat, may raise plasma metabolic biomarkers, particularly cholesterol and proteins (such as albumin). Second, the increased plasma activity of aspartate aminotransferase, which is synthesized in the liver, suggests that elevated exposure to HFRs and possibly other contaminants found in agricultural fields may have caused liver damage in the ring-billed gull. Alternative explanations for the rise in plasma phosphorus levels observed when foraging in agricultural fields are presented. The plasma biochemistry and underlying physiological processes of urban-dwelling birds may be affected by specific factors in urban and agricultural habitats (including other contaminants), which require additional research.

Declaration of Competing Interest

The authors declared that there is no conflict of interest.

Acknowledgment

None

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