

THE EFFECT OF THE NUMBER OF ANIMALS AND ENVIRONMENTAL CONDITIONS ON THE GASEOUS MICROCLIMATE OF BANK SWALLOW (*RIPARIA RIPARIA*) NESTS

Bank swallows, *Riparia riparia*, nest in underground colonies with up to 100 nests. The level of carbon dioxide (CO₂) in the nests may be high and oxygen (O₂) may be low depending on the number of birds in a nest, the number of nests in the colony, and the conditions of the soil.

Using a computer simulation, we tested the hypothesis that there is a limit to the number of animals (metabolic mass) that can occupy a nest before the gaseous environment becomes intolerable. The objective of this study was to determine the gaseous microclimate of bank swallow nests as a function of the metabolic mass of the animals, the porosity of the soil, and the proximity of adjacent nests. To accomplish this task, we used a computer simulation based on the principles of heat transfer through a semi-infinite solid. Because the laws of heat and mass transfer are the same, we only needed to substitute the diffusion coefficient of the gas for the coefficient of heat transfer and the gas concentration gradient for the temperature gradient.

The model closely predicted values of CO₂ and O₂ in bank swallow nests recorded from two different studies. The model also showed that under conditions of low soil porosity and high nest density, the number of animals in the nest becomes the limiting variable.

INTRODUCTION

The study's aim was to use a simulated computer model to examine the effect of soil porosity, metabolic rate, and colony density on the CO₂ output and the O₂ entering the nest. Our hypothesis stated that the only variables that affect the microclimate of a nest was the metabolic rate of the birds, soil porosity, and the distance between nests. We expected to find high CO₂ levels and low O₂ levels in the nest. We compared our findings with other similar studies.

METHODS

We built our computer model using Laboratory Virtual Instrument Engineering Workbench (LabVIEW). We used previously published equations and, for the heat transfer equation we substituted the gas diffusion coefficients for the coefficients of heat transfer. We tested our hypothesis by changing the variables that we expected would have an effect on the CO₂ and O₂ levels in the nest.

Data Analysis

The computer simulation allowed us to change the distance between the

Student Researcher: Thecla T. Ulroan
Mentor: Robert A. Furilla, PhD

nest, soil porosity values, CO₂ or O₂ levels, and the metabolic rate inside the nest. The metabolic rate and the CO₂ or O₂ levels show a linear relationship. As the metabolic rate increased, the level of the CO₂ increased. The level of CO₂ was 6.4% when the metabolic rate was set to 7 ml/min, which occurs with approximately one adult and five newly hatched babies.

CONCLUSION

We found that the CO₂ concentration rises with the metabolic rate. We also found that soil porosity is one of the main variables that affect the amount of CO₂ in the nest. Another important variable was the distance between each nest because each nest has an effect on the neighboring nest.

ACKNOWLEDGMENTS

The author would like to thank those who made it possible to reach the intended research goals: Dr. Robert A. Furilla; John Gregoire, University of Alaska Anchorage; Della Keats/ U-DOC; National Institute of Diabetes, Digestive and Kidney Disease (NIDDK); and Melissa Datta.

From the University of Alaska; Anchorage, Alaska and Chevak, Alaska.