Unraveling the foraging strategies of breeding seabirds by combining trajectory, activity, and physiology

Shiho Koyama koyama.40ko@nagoya-u.jp
Graduate School of Environmental Studies, Nagoya university

Yuichi Mizutani yuichi-san@nagoya-u.jp
Graduate School of Environmental Studies, Nagoya university

Ken Yoda yoda.ken@nagoya-u.jp
Graduate School of Environmental Studies, Nagoya university

Abstract

In this study, we recorded behavior of streaked shearwaters using GPS and acceleration data loggers and measured their oxidative stress levels as physiological cost. We used these data to analyze the relationship between foraging behavior and physiological costs. As a result, we found that anti-oxidative markers were positively correlated with maximum trip distance anti-oxidative markers were negatively correlated with number of times of homing. It suggest that shearwaters might forage for themselves in areas distant from the colony and bringing food to their chick might cause physiological stress for shearwaters.

Keywords: Seabirds, Behavior, GPS, Acceleration, Physiology, Oxidative stress

1. Introduction

Wild animals have evolved to forage food efficiently under various physiological constraints. Recently, bio-logging (i.e., the use of animal-borne data loggers) has been widely used to collect trajectory and activity data. However, there are not many studies that quantify physiological costs and integrate the behavior and physiology of free-living animals. It is especially difficult to study seabirds that routinely fly long distances to forage for food over several hundred kilometers.

During the breeding season, seabirds fly long distances to obtain food, not only for themselves, but also for their chicks that are waiting in the nest. Thus, how parents balance food between themselves and their chicks is important. To understand their foraging strategy, it is necessary to reveal what behavior is physiologically costly for them. They might use energy-saving flight [1], alternate between short and long foraging trips which are suitable for feeding their chicks and themselves, respectively [2], and/or selectively forage only high-quality food items.

In this study, we recorded the large- and fine-scale behavior of streaked shearwaters (*Calonectris leucomelas*) using GPS and acceleration data loggers and quantified physiological cost used by measurement their oxidative stress levels. We used these data to analyze the relationship between foraging behavior and physiological costs and to examine the foraging strategies of the shearwaters, which allow them to perform foraging trips at minimal cost.

2. Method

Fieldwork was performed breeding colony on Awashima Island (38°28′ N, 139°14′ E, Niigata, Japan) in the Sea of Japan in 2018 and 2019. To record their foraging behavior, we attached GPS

and acceleration loggers to breeding streaked shearwaters. The sampling intervals were one fix per minute for the GPS loggers and 25 Hz for the acceleration loggers. After 1–16 days, we re-caught the birds, retrieved the loggers, and measured their body metrics. We collected blood samples when we attached and recovered the loggers.

We defined a foraging trip as an extended trip of more than 3 km and 6 h from Awashima Island. We calculated the trip duration, total flight distance, and maximum trip range for each foraging trip. Based on the acceleration data, we classified the behavior of the streaked shearwaters as takeoff, gliding, and landing using k-means clustering. We measured oxidative and anti-oxidative markers in the blood samples and calculated oxidative stress.

3. Result

We tracked the foraging behavior of 26 (11 males and 15 females) and 24 (11 males and 13 females) streaked shearwaters in 2018 and 2019, respectively. We collected data for 151 trips (74 from males and 47 from females) and 38 trips (21 from males and 17 from females) in 2018 and 2019, respectively. We found that anti-oxidative markers were positively correlated with maximum trip distance. In addition, we found that the more frequently the shearwaters returned to the breeding island, the more severely they suffered oxidative stress. Meanwhile, there was no relationship between the number of flapping takeoffs and oxidative stress.

4. Conclusion

Anti-oxidative markers had a positive correlation with maximum trip range and a negative correlation with the number of colony returns. Shearwaters might forage for themselves in areas distant from the colony. Bringing food to their chick might cause physiological stress for them.There were no significant differences between the number of flapping takeoffs and oxidative stress in either the males or females. Since these results were based on data from 2018 only, the sample size might be too small. We intend to add the 2019 data and reconfirm our results.

Acknowledgements

This research was approved by the Animal Experimental Committee of Nagoya University (GSES 18 002). It was conducted with permits from the Ministry of the Environment and Agency for Cultural Affairs. This research was funded by the Grants-in-Aid for Scientific Research from the Japan Society of the Promotion of Science (JP16H06541) and the Sasakawa Scientific Research Grant from The Japan Science Society (2019-5003).

References

[1] Philip L. RICHARDSON, Ewan D. WAKEFIELD, and Richard A. PHILLIPS, “Flight speed and performance of the wandering albatross with respect to wind” Mov Ecol. doi: [10.1186/s40462-018-0121-9] (2018).

[2] Sakiko MATSUMOTO, Takashi YAMAMOTO, Maki YAMAMOTO, Carlos B ZAVALAGA, and Ken YODA, “Sex-related differences in the foraging movement of Streaked Shearwaters Calonectris leucomelas breeding on Awashima Island in the Sea of Japan” Ornithol Sci 16: 23 – 32 (2017).