Does Aging Change Foraging Behavior of Black-Tailed Gulls?

1st Hirokazu Suzuki
Graduate School of Environmental Studies
Nagoya University
Nagoya, Japan
suzuki.hirokazu@nagoya-u.jp

2nd Yuichi Mizutani
Graduate School of Environmental Studies
Nagoya University
Nagoya, Japan
yuichi-san@nagoya-u.jp

3rd Akira Narita
Aomori-prefectural Hachinohe Daiichi school for SNE
Hachinohe, Japan
umineko@htv-net.ne.jp

4th Ken Yoda
Graduate School of Environmental Studies
Nagoya University
Nagoya, Japan
yoda.ken@nagoya-u.jp

***Abstract*—How do wild animals behave as they get older? We investigated the foraging behavior of black-tailed gulls (*Larus crassirostris*) of known age using GPS and acceleration loggers. We found that the older gulls reduced their mean flight speed and tended to feed on prey on land rather than on prey at sea. However, breeding performance of gulls did not change with age. Therefore, older gulls might experience senescence, but optimize their foraging behavior in relation to their age to maintain breeding performance.**

Keywords—GPS, bio-logging, senescence, flight speed

I. Introduction

Aging is important in determining foraging behavior. For example, older individuals may lose the capacity to move efficiently, but may show improved foraging acquired during their extensive breeding experience. Revealing age-related foraging changes is of fundamental importance in understanding foraging strategy. Previous studies on age- related differences in behavior have been limited to seabirds that forage only at sea (e.g. [1]). We deployed GPS loggers and GPS-acceleration loggers on black-tailed gulls, *Larus crassirostris*, which are terrestrial and marine foragers, breeding on Kabushima Island, Aomori, Japan, to examine whether age affected gull foraging behavior.

II. Material and Methods

A. Subjects and study site

Black-tailed gulls (Fig. 1a) are in the Laridae family, and can be observed in coastal areas in Japan. The black-tailed gull colony on Kabushima Island (Hachinohe, Aomori, Japan, Fig. 1b) is one of the largest in Japan. Ecological research has been conducted on Kabushima Island since 1920. Because bird banders, who are certificated by Yamashina Institute for Ornithology, have annually ringed approximately 2,000 chicks since the 1970s, the colony includes many gulls of known age. A recent study demonstrated that gulls forage for anchovies at sea, aquatic insects in rice fields, food garbage at food plants and fish markets, and bread at the homes of local people [3].

B. Fieldwork

Fieldwork was conducted from April to July in 2012–2017 on Kabushima Island. We regularly checked nests throughout the breeding seasons to record breeding performance (the number of eggs, broods, fledglings, and chick growth). From the incubating phase to the early brooding phase (from early May to early June), we captured adult gulls using snares or by hand. We attached GPS loggers (GiPSy-2 and GiPSy-4, Technosmart, Italy) and GPS-acceleration loggers (Axy-Trek, Technosmart, Italy) on the gulls' backs using waterproof tape (Tesa 4651, Tesa SE, Germany). We set GPS sampling rates at 5 fixes/min (GiPSy-2), 30 sec/fix (GiPSy-4), 1 min/fix (Axy-Trek). After approximately one week, we recaptured tagged birds and retrieved loggers. We connected retrieved loggers to a PC using a cable, and downloaded behavioral data using special software. In this paper, we did not use acceleration data in the analysis.

C. Data analysis

We removed inaccurate points (Dilution of Precision > 7) and points that were considered too fast (> 70 km/h) from the GPS data. We interpolated the paths using piecewise cubic Hermite interpolating polynomial in Matlab (R2015a, Mathworks, US). We divided the data into each foraging trip (defined as movement of > 1 km, > 1 hour from the colony). We counted the number of points located on land for each trip using ArcMap (10.2, Esri, US). We defined trips during which gulls stayed on the land as land-based trips and other trips as sea-based trips. We calculated the following parameters for each individual: the number of trips, and the ratio of land-based- to total trips. We also calculated the following parameters for each trip: trip duration, total distance travelled, maximum range from the colony, mean speed, proportion of time in flight, and the numbers of landings/take-offs. We used Generalized Linear Mixed

978-1-5386-9151-9/19/$31.00 ©2019 IEEE

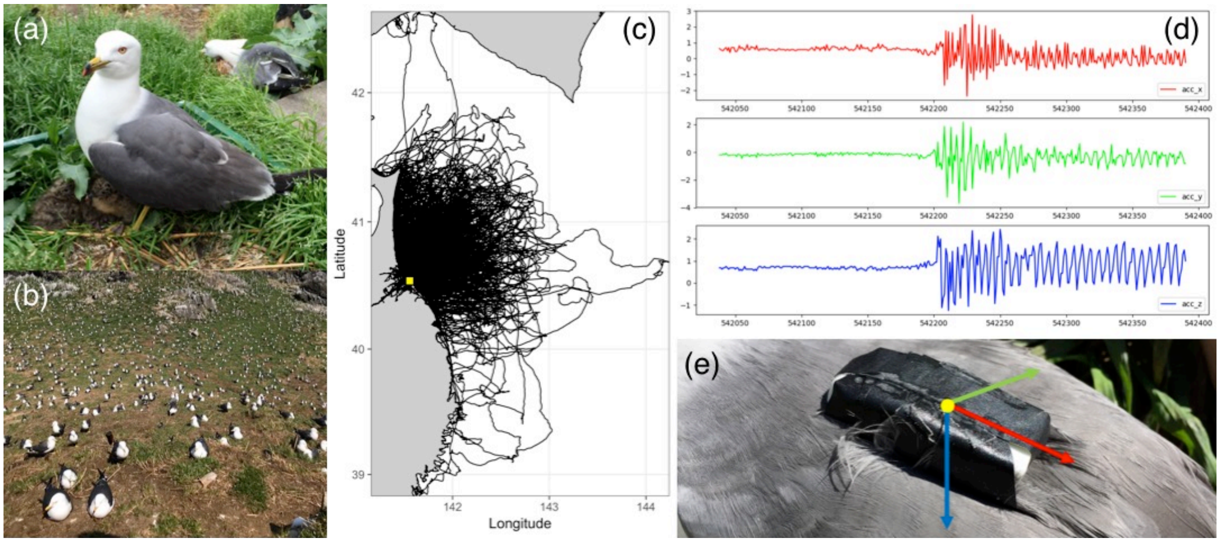

Fig. 1. (a) Black-tailed gulls and chicks. (b) Kabushima Island black-tailed gull colony during the incubating period. (c) Black-tailed gull movements recorded by GPS loggers in 2012–2017. The yellow square indicates the breeding colony location. (d) An example of acceleration patterns obtained from accelerometers attached to a gull. The gull was resting on land, and then the gull took off and flapped its wings in the air. (e) The GPS-acceleration logger attached to a gull's back. Each color of the axes corresponds to the colors of accelerations in Fig. 1e.

Models (GLMM), entering the above-mentioned parameters as dependent variables, age, sex and year as independent variables, and individual as a random effect, using "glmer" (involved in lme4 [4], R package). Finally, we selected the models with the lowest Akaike's Information Criterion (AIC), using "dredge" (involved in MuMIn [5], R package). We analysed the data using R [6].

III. Results

A. Data collected

We deployed GPS loggers on 150 gulls and retrieved movement paths from 110 gulls. The age range of the gulls was 8–30 years old. We extracted 959 trips from the data. Gulls visited both land and the sea (Fig. 1c).

B. Age-related changes in behavior

Gulls changed their foraging behavior in relation to age. Older gulls reduced their mean flight speed over the sea, the proportion of flight time during land-based trips, and the number of takeoffs/landings during land-based trips. Older gulls also increased the ratio of land-based trips. However, gulls did not change breeding performance in relation to their age.

IV. Discussion

Gulls reduced their mean flight speed with age, indicating that they might experience senescence. Some bird species were found to reduce their flight speed with age (e.g. zebra finch, *Taeniopygia guttata* [2], this study), although others were not found to change their flight speed with age (e.g. wandering albatross, *Diomedea exulans* [1]). As the former and latter groups mainly use flapping and gliding flights, respectively, speed reduction with age might be caused by a decreased capacity for wing flapping. We are analyzing the relationship between age and flapping recorded by acceleration loggers to examine the cause of decreasing speed in older black-tailed gulls.

Gulls might be reluctant to fly because of their senescing capacity to flap. Gulls might increase the proportion of land-based trip in order to reduce flight costs, because land-based trips (mean distance: 41 km) were shorter in distance than sea-based trips (mean distance: 130 km). Moreover, experience might make gulls more efficient foragers. Gulls might memorize the positions of immobile foraging sites. The flight performance of gulls decreased with age, but gulls could change habitats and how they move, in order to maintain breeding success.

V. Needs

A. Visualization of acceleration data

An activity recognition is a promising technique for automated assessment of long-term data. To classify activities of animals using the technique, we have to label the data manually. However, we often can not label some activities and postures from acceleration of wildlife (Fig. 1d, 1e), which are rarely observed directly in the field. There are some techniques to estimate postures using inertial sensors (e.g. [7]). We want (1) to calculate the postures of animals from acceleration data using the above techniques, and (2) to visualize the motions using 3D models on the display. If we could do these things, this would enable us not only to label animal's motions but also to visualize these motions.

Acknowledgement

This work was supported by JSPS KAKENHI (grant numbers JP16H06541, JP16H01769), the Cooperation Research Program of Wildlife Research Center, Kyoto University.

References

[1] H. Froy, S. Lewis, P. Catry, C. M. Bishop, I. P. Forster, A. Fukuda, H. Higuchi, B. Phalan, J. C. Xavier, D. H. Nussey, R. A. Phillips, "Age-related variation in foraging behaviour in the wandering albatross at South Georgia: No evidence for senescence," PLoS ONE, 10(1): e0116415, 2015.

[2] M. K. Labocha, J. Rutkowska, M. Cichon, and U. Bauchinger, "Age-specific decline in take-off flight performance in a small passerine," Anim. Behav., Vol. 105, pp. 103–107, 2015.

[3] K. Yoda, N. Tomita, Y. Mizutani, A. Narita, and Y. Niizuma, "Spatio-temporal responses of black-tailed gulls to natural and anthropogenic food resources," Mar. Ecol. Prog. Ser., Vol. 466, pp. 249–259, 2012.

[4] D. Bates, M. Maechler, B. Bolker, and S. Walker, "Fitting Linear Mixed-Effects Models Using lme4," J. Stat. Softw., Vol. 67(1), pp. 1-48, 2015.

[5] K. Bartoń, "MuMIn: Multi-Model Inference," R package version 1.42.1. https://CRAN.R-project.org/package=MuMIn, 2018.

[6] R Core Team, "R: A language and environment for statistical computing," R Foundation for Statistical Computing, Vienna, Austria, URL https://www.R-project.org/, 2018.

[7] J. L. Crassidis, F. L. Markley, and Y. Cheng, "Survey of Nonlinear Attitude Estimation Methods," J. Guid. Control and Dyn., Vol. 30(1), pp. 12-28, 2007.