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Supplementary material

Supplementary material

Appendix 1

Analysis of acceleration data:

Of the three axes of accelerations, only dorsoventral acceleration was analyzed in this study. A spectrogram of dorsoventral acceleration was calculated by continuous wavelet transformation (CWT) using Ethographer ver. 2.03 (Sakamoto et al. 2009) implemented on Igor Pro ver. 6 (WaveMetrics Inc., Lake Oswego, USA). This analysis performs time-scale decomposition of the signal, and can quantify both the dominant modes of variability and how those modes vary over time (Torrence & Compo 1998). We created a spectrogram in intervals of 0.2 seconds by CWT using the Morlet wavelet function with a minimum cycle of 0.16 seconds and a maximum cycle of 1 second. The non-dimensional frequency, which determines the balance of decomposition resolution between the time and periodicity domains, was set to 10 (Sakamoto et al. 2009). The dominant cycle of the acceleration was calculated and extracted using the peak tracer function in Spectrum Analysis of Ethographer. We set the threshold of dominant amplitude in the peak tracer at 0.20–0.25 for each individual to extract flapping phases. We limited use of flapping phases with a duration of 2 seconds or greater in order to reduce noise and eliminate sporadic wing flaps.

Statistical analyses were performed using R ver. 3.2.1. To examine the relationship between time spent outside burrows and time spent exercising wings, we performed a general linear mixed model using the ‘lmer’ function in the ‘lme4’ package (Bates et al.

2015). Individual ID was included as a random factor in all models. Significance was determined using the ‘lmerTest’ package (Kuznetsova et al. 2015).

Supplementary references

Bates, D., Maechler, M., Bolker, B., Walker, S. 2015. Fitting linear mixed-effects models using lme4. - J Stat Softw 67: 1–48.

Kuznetsova, A., Brockhoff, P. B., Christensen, R. H. B. 2016. lmerTest: Tests in linear mixed effects models. R package version 2.0-32. http://CRAN.R-project.org/package=lmerTest

Sakamoto, K. Q., Sato, K., Ishizuka, M., Watanuki, Y., Takahashi, A., Daunt, F., Wanless, S. 2009. Can ethograms be automatically generated using body acceleration data from free-ranging birds? - PloS ONE 4: e5379.

Torrence, C., Compo, G. P. 1998. A practical guide to wavelet analysis. - Bull Am Meteor Soc 79: 61–78.

Figure caption

Figure A1. (a) Daily excursion time in relation to days before fledging. Daily excursion time steadily increased with the approach of fledging. (b) Cumulative excursion time in relation to the number of excursions; data for two chicks are shown here as examples. The large circles indicate fledging. On average, the chick represented by the red dots exhibited longer excursion times during each trip than did the chick represented by the black dots. The relationship could be modeled by the equation $y = a \cdot x^2$, where a is a coefficient indicating the degree of individual tendency for excursion. For the chick represented in the red dots, $a = 2.39$ (n = 36), whereas for the chick represented by the black dots, a = 0.37 (n = 66).

Figure A1

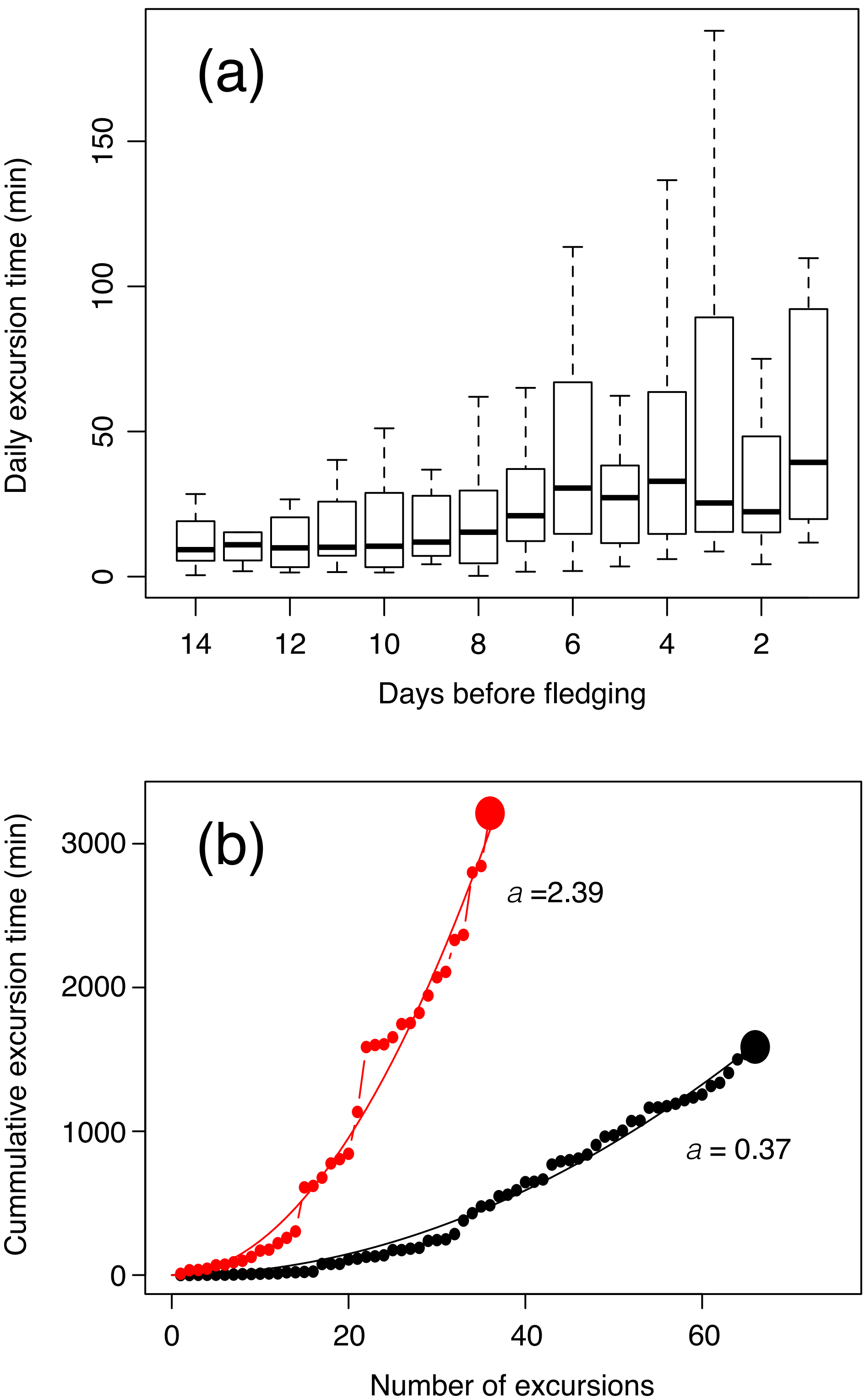
(a)
Daily excursion time (min)
0
50
100
150
14
12
10
8
6
4
2
Days before fledging
(b)
Cummulative excursion time (min)
0
1000
2000
3000
a =2.39
a = 0.37
0
20
40
60
Number of excursions

Table A1. Bird ID, emergence period, mean and total excursion time, and number of excursions.

Bird ID	Emergence period (days)	Mean excursion time (min)	Total excursion time (min)	Number of excursions
1	17	18.29	859.48	47
2	18	23.49	1221.42	52
3	11	40.67	732.13	18
4	12	32.51	1463.12	45
5	8	69.66	1741.43	25
6	22	24.04	1586.48	66
7	11	23.35	817.17	35
8	15	9.37	337.27	36
9	17	32.40	2397.35	74
10	13	29.93	778.15	26
11	13	34.42	998.27	29
12	14	23.49	892.55	38
13	13	35.52	1314.35	37
14	20	34.56	2350.20	68
15	22	25.24	1539.63	61
16	21	89.22	3211.80	36
17	12	19.50	390.02	20
18	15	55.75	1282.28	23
19	14	15.97	654.60	41
20	13	14.77	413.52	28