

Timing of fruiting rather than topography determines the direction of vertical seed dispersal by mammals and birds

Y. Tsunamoto^{1†}, S. Koike², I. Tayasu³, T. Masaki⁴, S. Kato⁵, S. Kikuchi⁴, T. Nagamitsu⁴, T. Haraguchi³, T. Naganuma⁶, S. Naoe^{1*}

Supplementary Materials

Fig. S1. Calibration lines (i.e., negative correlation between altitudes and the isotope ratio of non-dispersed reference seeds) for the vertical seed dispersal distance of (A) *Cerasus leveilleana* and (B) *Padus grayana*. Dots indicate non-dispersed reference seeds, and lines indicate calibration lines.

Table S1. Detailed sampling of the target species *Cerasus leveilleana* and *Padus grayana* in the Ashio-Nikko Mountains (ASH), Abukuma Highlands (ABU), and Kanto Mountains (KAN). We only estimated the vertical seed dispersal distance of dispersed seeds that were collected in the same year that the calibration line was made (see Methods for details).

Table S2. Number of dispersed and analyzed seeds of *Cerasus leveilleana* and *Padus grayana*.

Table S3. Results of Bayesian inference for calibration lines (oxygen isotope ratio of seed = $a \times$ altitude + b) of *Cerasus leveilleana* and *Padus grayana*.

Table S4. Observed and expected absolute mean vertical seed dispersal distances of *Cerasus leveilleana* and *Padus grayana* in ASH, ABU, and KAN.

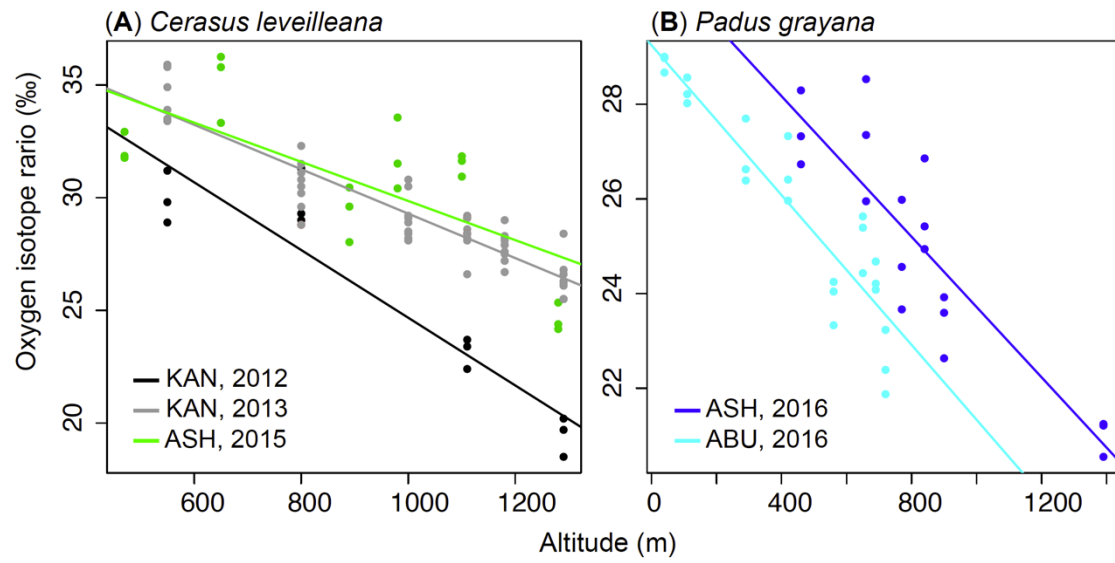


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Mountains	Latitude	Longitude	Species	Vertical distribution of species (m)	Census altitude (m)	Census route (km)	Target frugivore	Sampling year	Seed dispersal quantity	Vertical seed dispersal distance
ASH	36.7°N	139.5°E	<i>C. leveilleana</i>	450–1,150m	1,050–1,200m	2	mammal, bird	2014	✓ †	
								2015	✓ †	✓
			<i>P. grayana</i>	450–1,400m	850–950m	2	mammal, bird	2014	✓	
								2016	✓	✓
ABU	36.9°N	140.6°E	<i>C. leveilleana</i>	400–880m(summit)	600–750m	2	mammal, bird	2014	✓ †	
								2015	✓ †	✓
			<i>P. grayana</i>	0–880m(summit)	550–700m	2	mammal, bird	2014	✓	
								2016	✓	✓
KAN*	35.8°N	139.0°E	<i>C. leveilleana</i>	550–1,300m	550–1,650m	16	mammal	2010–2013	✓	✓

*Data are from Naoe et al. 2016.

†Sampling method of bird-dispersed seed between years are different. See Methods for details.

Table S2. Number of dispersed and analyzed seeds of *Cerasus leveilleana* and *Padus grayana*.

Species	Mountains	Year	Frugivore	No. of dispersed seeds	No. of analyzed seeds
<i>C. leveilleana</i>	ASH	2014	Bear	850	0
			Macaque	813	0
			Raccoon dog	99	0
			Marten	175	0
			Bird	29	0
	ABU	2014	Raccoon dog	147	0
			Marten	577	0
			Bird	8	0
	ASH	2015	Bear	3029	13
			Macaque	770	43
			Marten	1348	66
			Bird	105	23
ABU	2015	Marten	513	0	
		Bird	14	0	
<i>P. grayana</i>	ASH	2014	Bear	1688	0
			Macaque	733	0
			Marten	723	0
			Bird	73	0
	ABU	2014	Marten	1175	0
			Raccoon dog	40	0
			Bird	1509	0
	ASH	2016	Bear	3066	17
			Macaque	32	1
			Marten	1495	28
			Bird	170	47
	ABU	2016	Raccoon dog	240	2
Marten			595	18	
Bird			121	26	
Total				20137	284

Table S3. Results of Bayesian inference for calibration lines (oxygen isotope ratio of seed = $a \times \text{altitude} + b$) of *Cerasus leveilleana* and *Padus grayana*.

Species	Mountains	Year	Parameter	Mean	SD	2.5%	25%	50%	75%	97.5%	Rhat
<i>C. leveilleana</i>	ASH	2015	a	-0.0087	0.0025	-0.0136	-0.0103	-0.0087	-0.0071	-0.0039	1.0016
			b	38.5	2.3	34.0	37.0	38.5	40.0	43.2	1.0017
	KAN	2012	a	-0.0150	0.0021	-0.0193	-0.0164	-0.0151	-0.0137	-0.0106	1.0011
			b	39.7	2.1	35.4	38.4	39.7	41.0	43.9	1.0011
		2013	a	-0.0099	0.0007	-0.0111	-0.0103	-0.0099	-0.0094	-0.0085	1.0008
			b	39.2	0.7	37.8	38.7	39.2	39.6	40.5	1.0009
<i>P. grayana</i>	ASH	2016	a	-0.0074	0.0011	-0.0095	-0.0081	-0.0074	-0.0067	-0.0053	1.0009
			b	31.1	0.9	29.3	30.6	31.2	31.7	33.0	1.0008
	ABU	2016	a	-0.0079	0.0007	-0.0094	-0.0084	-0.0079	-0.0074	-0.0064	1.0009
			b	29.2	0.4	28.5	29.0	29.3	29.5	30.0	1.0008

Table S4. Observed and expected absolute mean vertical seed dispersal distances of *Cerasus leveilleana* and *Padus grayana* in the Ashio-Nikko Mountains (ASH), Abukuma Highlands (ABU), and Kanto Mountains (KAN).

Species	Mountains	Observed absolute mean vertical seed dispersal distance (m)					Expected absolute mean vertical seed dispersal distance (m)				
		Bear	Macaque	Raccoon dog	Marten	Bird	$r = 0.1$	$r = 0.5$	$r = 1$	$r = 3$	$r = 10$
<i>C. leveilleana</i>	ASH	292.9 ± 29.3	314.6 ± 20.9		333.6 ± 18.6	328.8 ± 26.6	13.2 ± 0.4	46.8 ± 1.5	67.2 ± 2.1	137.8 ± 4.2	237.2 ± 7.4
	KAN	330.6 ± 28.8			235.1 ± 23.1		27.3 ± 1.1	81.4 ± 3.1	146.2 ± 5.2	231.4 ± 7.3	302.9 ± 9.3
<i>P. grayana</i>	ASH	122.5 ± 2.3	31.3		132.2 ± 23.0	105.3 ± 12.2	21.4 ± 0.9	59.0 ± 2.4	104.9 ± 4.0	196.3 ± 7.6	318.4 ± 11.6
	ABU			56.5 ± 19.3	120.0 ± 18.8	172.9 ± 21.6	8.7 ± 0.5	24.8 ± 1.5	42.5 ± 2.5	75.3 ± 3.4	86.5 ± 4.7