Interspecific Difference in Seed Dispersal Characteristics between Japanese Macaques (*Macaca fuscata*) and Sympatric Japanese Martens (*Martes melampus*)

Yamato Tsuji^{a, b} Risma Yanti^c Atsushi Takizawa^d Toshio Hagiwara^d

^aPrimate Research Institute, Kyoto University, Inuyama, Japan; ^bIshinomaki Senshu University, Ishinomaki, Japan; ^cBogor Agricultural University, Bogor, Indonesia; ^dJigokudani Monkey Park, Yamanouchi-Machi, Japan

Keywords

Macaca fuscata · *Martes melampus* · Seed dispersal effectiveness · Shiga Heights · Sympatric mammals

Abstract

We compared the characteristics of seeds within faeces between semi-terrestrial Japanese macaques (*Macaca fuscata*) and sympatric arboreal Japanese martens (*Martes melampus*) in Shiga Heights, central Japan. We collected faecal samples of the two mammalian species for 1 year ($n = 229$ for macaques and $n = 22$ for martens). We then compared the proportion of seed occurrence, life-form composition, number of seeds and species richness within single faecal samples, and the seed intact ratio between the two mammalian species. We detected seeds from 20 and 7 species from macaque and marten faeces, respectively. Macaque faeces contained seeds of multiple strata, while marten faeces contained no herbaceous plant seeds. Seed sizes within faeces showed no interspecific difference. For macaques, seeds were found within faecal samples collected in late spring to late fall, while for martens, seeds were found between summer and winter. The proportion of seed occurrence was greater in summer (both species) and fall (macaques), which implied that the seed dispersal roles of macaques and martens was greater in these seasons. The mean seed number (across species), intact ratio of seeds (high for both species) and seed species richness within single faecal samples of macaques and martens showed no significant differences, but for several species, martens defecated more seeds than macaques and showed higher intact ratio. Our study indicates that sympatric mammals in the temperate regions of Japan contribute differently to seed dispersal in forest ecosystems.

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Introduction

A recent trend of endozoochorous seed dispersal is to address the relative contribution of target frugivores to the dispersal service. Previous studies have tried to evaluate the contribution of a single species as dispersal agent, but recent studies revealed that the fruit-frugivore relationship is not specific, and dispersal is performed through a multi-fruit/multi-frugivore network [McConkey and Brockelman, 2011]. In the tropical region, the relative contribution of primates to seed dispersal is often higher than that of sympatric frugivores [McConkey and Brockelman, 2011; Moreira et al., 2017]. Primates also inhabit the temperate region, but the cross-species comparisons that are required to truly evaluate the importance of primates have not been conducted.

In this report, we compare the seed dispersal characteristics of the sympatric mammalian frugivores, Japanese macaques (*Macaca fuscata*) and Japanese martens (*Martes melampus*), in the snowy region of Japan.

Materials and Methods

We conducted a survey of wild Japanese monkeys in the Shiga A troop. As of 2017, the troop comprised 187 animals. They inhabited the Yokoyugawa Valley, Shiga Heights, Nagano Prefecture (36°43', 138°27', approximately 800 m a.s.l.). They have been provisioned since 1962 [Wada and Ichiki, 1980], and the continuous provisioning had shifted their home range to near the provisioning site (Jigokudani Monkey Park [JMP]). The home range area of the Shiga A troop during the study period was 6–9 km². The forest around JMP is dominated by planted *Cryptomeria japonica* and wild *Betula* spp. and *Quercus* spp. in the lower areas and *Fagus crenata* in the higher areas [Wada and Ichiki, 1980]. The staff provisioned foods daily. Tourists were prohibited from feeding the animals. The macaques depend heavily on the provisioned foods in winter and stay at JPM from 08:00 to 17:00, but the majority of their diet in other seasons is composed of wild plants, and they often do not come to JMP in summer and fall. Thus, we accept the possibility that provisioning can affect their natural food items, including fruits and seeds.

Fresh faecal samples of adult macaques were collected at JMP between May 2018 and April 2019 (12 surveys, 30 days in total). We collected the fresh faeces of sympatric Japanese martens along the forest path (1.6 km in length) on the way back and forth to JMP in each month, except for August 2018 and February 2019 (20 surveys in total): we walked the path slowly (4 km/h) and collected the marten faeces along it. Since the martens prefer to defecate at open habitats [Yasumoto and Takatsuki, 2015], our sampling method seemed appropriate. We could identify the marten faeces based on their shape, width, and odour. Faecal samples of both mammalian species were thoroughly mixed with water and rinsed through 0.5-mm sieves under fresh water.

We removed all seeds from the bottled faecal samples and tried to identify them to the species level. Seed identification was based on a reference collection established by JMP staff in previous years, as well as on reference books [Nakayama et al., 2000]. We classified the identified species into 4 life forms: high trees (>5 m in height), shrubs (<5 m), lianas, and herbaceous plants.

We measured the longest (a_1), second longest (a_2), and third longest axis (a_3) of up to 10 randomly selected seeds picked up from faeces for each plant species to the nearest 0.01 mm using a digital Vernier caliper. We then calculated the mean cubic diameter (MCD) of each seed: $MCD = (a_1 \times a_2 \times a_3)^{1/3}$. After taking these measurements, we counted the total number of seeds and the number of “intact seeds,” defined as those seeds that appeared to be complete, within each bottled sample. For plant species whose seeds were relatively large ($MCD \geq 1.5$ mm), we directly counted the numbers of both the total and intact seeds within the entire bottled sample. In case of smaller seeds ($MCD < 1.5$ mm), we estimated the total seed number (both whole and intact) from subsamples (~1 g in dry weight).

Table 1. Monthly changes in dispersal events and total numbers of seeds and species within single faecal samples defecated by Japanese macaques in Shiga Heights, central Japan

Month	Faecal sample, <i>n</i>	DE	DE _r	Σ of seeds	Σ of intact seeds	IR	Seeds per faeces, <i>n</i>	Species per faeces, <i>n</i>
<i>Spring</i>								
March	12	0	0.00***	–	–	–	–	–
April	12	0	0.00***	–	–	–	–	–
May	19	17	0.89**	2	0	0.00 ^{ns}	1.0±0.0	1.0±0.0
<i>Summer</i>								
June	22	19	0.86**	2,604	2,595	1.00***	137.1±323.9	1.1±0.3
July	23	9	0.39 ^{ns}	1,548	1,548	1.00***	172.0±397.7	1.2±0.4
August	22	14	0.64 ^{ns}	352	351	1.00***	25.1±41.8	1.4±0.8
<i>Fall</i>								
September	20	20	1.00***	1,113	1,112	1.00*	35.7±107.5	2.2±0.7
October	26	25	0.96***	1,230	1,216	0.99*	49.2±57.4	2.8±1.4
November	20	20	1.00***	1,056	1,034	0.98***	52.8±45.7	2.3±1.1
<i>Winter</i>								
December	19	0	0.00***	–	–	–	–	–
January	20	0	0.00***	–	–	–	–	–
February	14	0	0.00***	–	–	–	–	–
Annual mean	229	124	0.54	7,905	7,856	0.99	72.5±186.4	1.9±1.1

Values are presented as means ± SD. Results of binomial tests are also shown. DE, dispersal event; DE_r, ratio of dispersal event; IR, intact ratio; ns, not significant (*p* > 0.05). *** *p* < 0.001, ** *p* < 0.01, * *p* < 0.05.

For evaluating the seed characteristics, we first calculated the number of dispersal events (DE), which was defined as the number of faecal samples containing seeds, for each month and for each plant species. We also calculated DE ratios (DE_r), obtained by dividing DE by the number of faecal samples examined for each month and for each plant species. To determine the primary month(s) of the DE for a given species, we compared the number of intact seeds in a given month to the seed’s annual mean. The months during which the former was greater than the latter were defined as main seed dispersal months. From this calculation, we obtained the primary seed dispersal season(s). We measured the species richness and calculated an intact ratio (IR), a proxy of the qualitative component of the seed dispersal for each month and for each plant species. The IR was obtained by dividing the total number of intact seeds in a given month by the total number of intact seeds of a given species during the entire study period. We compared the DE_r, life-form composition, MCD of seeds, mean number of seeds within single faeces, mean plant species richness within single faeces, and IRs between macaques and martens.

Results

We collected 229 macaque faecal samples during the study period (Table 1). The numbers of faecal samples collected in March, April (*n* = 12 for each), and February (*n* = 14) were lower than those for the other months, which may have affected the later results. The annual mean DE_r was 0.54 (124/229), and about 7,900 seeds were collected from the macaque faeces (Table 1). Compared to the annual mean, the DE_r

Table 2. Monthly changes in dispersal events and total numbers of seeds and species within single faecal samples defecated by Japanese martens in Shiga Heights, central Japan

Month	Faecal sample, <i>n</i>	DE	DE _r	Σ of seeds	Σ of intact seeds	IR	Seeds per faeces, <i>n</i>	Species per faeces, <i>n</i>
<i>Spring</i>								
March	1	0	0.00	–	–	–	–	–
April	2	0	0.00	–	–	–	–	–
May	0	–	–	–	–	–	–	–
<i>Summer</i>								
June	4	4	1.00	620	620	1.00	155.0±263.4	1.3±0.5
July	3	0	0.00	–	–	–	–	–
August	–	–	–	–	–	–	–	–
<i>Fall</i>								
September	0	–	–	–	–	–	–	–
October	2	2	1.00	424	424	1.00	212.0±90.5	1.0±0.0
November	5	4	0.80	94	94	1.00	23.5±23.9	1.8±1.0
<i>Winter</i>								
December	3	1	0.33	1	1	1.00	1.0	1.0
January	2	1	0.50	45	45	1.00	45.0	2.0
February	–	–	–	–	–	–	–	–
Annual mean	22	12	0.55	1,184	1,184	1.00	98.7±162.8	1.4±0.7

Values are presented as means ± SD. Results of binomial tests are also shown. DE, dispersal event; DE_r, ratio of dispersal event; IR, intact ratio.

values in May, June, September, October, and November were significantly higher (binomial tests, $p < 0.05$), whereas those in March, April, December, January, and February were significantly lower ($p < 0.05$). The DE_rs in July and August did not significantly differ from the annual mean ($p > 0.05$; Table 1). The annual mean IR of seeds within macaque faeces was 0.99 (7,856/7,905). The IRs in October and November were significantly lower than the annual mean (binomial tests, $p < 0.05$), while those from June to September were significantly greater than the annual mean ($p < 0.05$). In May, the IR was not significantly different from the annual mean ($p > 0.05$; Table 1).

On the other hand, we collected 22 marten faecal samples during the survey (Table 2). Due to smaller sample size, we must accept the possibility that our analyses for the martens may be biased. We collected no marten faeces in May and September 2018. The annual mean DE_r was 0.55 (12/24), and in total, about 1,200 seeds were collected from marten faeces (Table 2). The DE_r in June was significantly higher than the annual mean (binomial tests, $p < 0.05$), while those in other months showed no difference from the annual mean ($p > 0.05$, Table 2). The IR of the marten seeds was 1.0 (no broken seeds).

We identified 20 different plant species (15 families) from macaque faecal samples (Table 3). All seeds were from fleshy fruited plant species. These species included 6 high trees, 7 shrubs, 4 lianas, and 3 herbaceous plants. The total number of accumulated plant species was highest in fall (September to November) (9–12 species in

Table 3. Seeds found within faecal samples of Japanese macaques in Shiga Heights, central Japan (May 2018 to April 2019)

Food plant species	Life form	Feeding record ^a	MCD, mm	DE	DE _r	Seeds	Month in which intact seeds appeared ^b	<i>p</i> value ^c	Main season(s) in seed appearance	Σ of seeds	Σ of intact seeds	IR
Betulaceae												
<i>Alnus</i> sp.	High tree	N	2.21±0.24 (n = 2)	3	0.01	1.0±0.0	Oct, Nov	–	F	3	3	1.00
Magnoliaceae												
<i>Magnolia obovata</i>	High tree	Y	5.69 (n = 1)	3	0.01	1.0±0.0	Oct	–	F	3	1	0.33
Schisandraceae												
<i>Schisandra nigra</i>	Liana	Y	4.06±0.19 (n = 10)	3	0.01	1.7±1.2	Aug, Sep, Nov	0.368	F	5	5	0.00
Actinidiaceae												
<i>Actinidia arguta</i>	Liana	Y	1.53±0.10 (n = 10)	37	0.16	45.1±84.1	Aug, Sep, Oct, Nov	0.259	F	1,669	1,668	1.00
Rosaceae												
<i>Prunus</i> spp. ^d	High tree	Y	4.54±0.37 (n = 10)	15	0.07	8.1±8.6	Jun, Jul	0.198	Su	184	175	0.95
<i>Rubus</i> spp. ^e	Shrub	Y	1.33±0.08 (n = 10)	12	0.05	335.1±469.1	Jun, Jul	0.745	Su	4,021	4,021	1.00
<i>Sorbus commixta</i>	Shrub	Y	2.32±0.49 (n = 10)	5	0.02	4.6±5.7	Aug, Sep, Oct, Nov	0.626	F	23	23	1.00
<i>Pourthiaea villosa</i>	Shrub	Y	2.38±0.33 (n = 10)	24	0.10	8.5±13.0	Oct, Nov	0.096	F	171	144	0.84
Celastraceae												
<i>Celastrus orbiculatus</i>	Liana	Y	2.40±0.14 (n = 10)	5	0.02	4.8±5.3	Nov	–	F	24	23	0.96
Vitaceae												
<i>Vitis coignetiae</i>	Liana	Y	4.02±0.32 (n = 10)	70	0.31	22.7±33.7	May, Jul, Aug, Sep, Oct, Nov	0.003	F	1,590	1,587	1.00
Stachyuraceae												
<i>Stachyurus praecox</i>	Shrub	Y	1.48±0.26 (n = 10)	1	0.00	3	Sep	–	F	3	3	0.00
Garryaceae												
<i>Aucuba japonica</i>	Shrub	N	4.63±0.82 (n = 2)	2	0.01	1.0±0.0	Oct	–		2	2	1.00
Cornaceae												
<i>Cornus controversa</i>	High tree	Y	3.28 (n = 1)	2	0.01	1.0±1.0	Sep, Oct	–	F	2	1	0.50
<i>Cornus kousa</i>	High tree	Y	3.50±1.21 (n = 4)	2	0.01	1.5±0.7	Aug, Sep	0.317	Su, F	3	2	0.67
Ericaceae												
<i>Vaccinium oldhamii</i>	Shrub	Y	1.01±0.07 (n = 9)	2	0.01	4.0±2.8	Sep, Oct	0.317	F	8	8	1.00
<i>Enkianthus perulatus</i>	Shrub	N	6.38 (n = 1)	1	0.00	1.0	Nov	–	F	1	1	1.00
Lamiaceae												
<i>Clerodendrum trichotomum</i>	High tree	N	4.44±0.20 (n = 10)	1	0.00	38.0	Sep	–	F	38	38	1.00
Poaceae												
Poaceae sp.	Herbaceous	N	1.62±0.24 (n = 4)	4	0.02	1.3±0.5	Jul, Aug, Oct	0.223	Su, F	5	5	1.00

Table 3 (continued)

Food plant species	Life form	Feeding record ^a	MCD, mm	DE	DE _r	Seeds	Month in which intact seeds appeared ^b	<i>p</i> value ^c	Main season(s) in seed appearance	Σ of seeds	Σ of intact seeds	IR
Polygonaceae												
Polygonaceae sp.	Herbaceous	Y	1.80±0.26 (n = 10)	13	0.06	2.3±1.4	Aug, Sep, Oct, Nov	0.485	F	30	29	0.97
Solanaceae												
Solanaceae sp.	Herbaceous	N	1.65±0.09 (n = 2)	1	0.00	2.0	Oct	–	F	2	2	1.00
Unknown A	?	–	–	3	0.01	1.0±0.0	May, Aug, Oct	–	Sp, Su, F	3	1	0.33
Unknown B	?	–	–	2	0.01	73.5±64.3	Oct	–	F	147	147	1.00

DE, dispersal event; DE_r, rate of dispersal event; IR, intact rate; MCD, mean cubic diameter of seeds. ^a Y: the plant species recorded in the diet of macaques in Shiga Heights [Tsuji et al., 2011, 2012]. The main diets in these articles are shown in bold. ^b Names of each month are abbreviated. Months in which the number of intact seeds exceeds the annual mean are shown in bold. ^c *p* values <0.05 are shown in bold. ^d Including *Prunus levilleana*, *P. sargentii* and *P. grayana*. ^e Including *Rubus crataegifolius* and *R. palmatus*.

each month) and lower in spring and summer (1–7 species) (Fig. 1a). On the other hand, we identified 7 plant species (6 families) from marten faecal samples (Table 4). There are 2 species not dispersed by the macaques (*M. bombycis* and *D. kaki*) and 1 species which martens dispersed intact but macaques chewed up (*S. praecox*). All seeds were from fleshy fruited plant species. These species included 2 high trees, 3 shrubs and 2 lianas. The total numbers of accumulated plant species were highest in June and November (3 species each) (Fig. 1b).

The mean (± SD) total number of seeds within single macaque faecal samples was 72.5 ± 186.4 and exhibited significant monthly variation (Kruskal-Wallis test, $\chi^2 = 14.5$, df = 6, *p* = 0.025) (Table 1: the greatest in July [172.0 ± 397.7] and lowest in May [1.0 ± 0.0]). Of the 20 identified plant species, one (*Vitis coignetiae*) exhibited significant monthly variation in the number of intact seeds (Kruskal-Wallis tests, $\chi^2 = 17.9$, df = 5, *p* = 0.003) (Table 3). Of the 124 faecal samples that contained seeds, the mean seed species richness was 1.9 ± 1.1 (range: 1–6). The seed species richness showed significant monthly variation ($\chi^2 = 45.5$, df = 6, *p* < 0.001), and a post hoc test found that the number of species in October was larger than that in the other months (Table 1). On the other hand, the mean (± SD) total number of seeds within a single marten faecal sample was 98.7 ± 162.8, and the number was stable throughout the year ($\chi^2 = 5.2$, df = 4, *p* = 0.268) (Table 2). The number of seeds was greatest in October (212.0 ± 90.5) and lowest in December (1.0), respectively. Of the 12 marten faecal samples that contained intact seeds, the mean seed species richness was 1.4 ± 0.7 (range: 1–3) (Table 2). The seed species richness showed no significant monthly variations ($\chi^2 = 3.6$, df = 4, *p* = 0.468) (Table 2).

The total number of seeds showed no interspecific difference ($\chi^2 = 0.9$, df = 1, *p* = 0.331), but in *A. arguta* and *Prunus* spp., for which we obtained enough samples from 2 animals, we found significant interspecific differences in mean seed numbers (*A. arguta*: $\chi^2 = 9.2$, df = 1, *p* = 0.002; *Prunus* spp.: $\chi^2 = 4.6$, df = 1, *p* = 0.031): for both plant species, martens defecated a greater number of seeds than did macaques. We found no difference in the number of *V. coignetiae* seeds ($\chi^2 = 2.1$, df = 1, *p* = 0.152)

Fig. 1. Monthly changes in the accumulated number of plant seeds found within faecal samples of Japanese macaques (**a**) and Japanese martens (**b**) between May 2018 and April 2019. Life-form composition (categorized into high trees, shrubs, lianas, and herbaceous plants) is also shown. Unidentified species are omitted. The whole year was separated into 4 seasons: spring (March–May), summer (June–August), fall (September–November), and winter (December–February). Numbers in parentheses represent the number of collected faecal samples. Data on martens in August 2018 and February 2019 are lacking.

(Tables 3, 4). The seed species richness showed no significant interspecific difference ($\chi^2 = 2.8$, $df = 1$, $p = 0.092$). Finally, the MCDs ($\pm$ SD) of seeds dispersed by macaques and martens were 3.0 ± 1.6 mm (range: 1.3–6.4) and 2.9 ± 1.8 mm (range: 1.3–5.7), respectively, and showed no significant interspecific differences ($\chi^2 = 0.5$, $df = 1$, $p = 0.489$) (Tables 3, 4).

Discussion

In summer and fall (June–November), the DE_r values for both macaques and martens were greater than their annual means (Tables 1, 2). In these seasons, the seed species richness was also high (Fig. 1), and the number of intact seeds peaked for

Table 4. Seeds found within faecal samples of Japanese martens in Shiga Heights, central Japan (May 2018 to April 2019)

Food plant species	Life form	MCD, mm	DE	DE _r	Seeds, <i>n</i>	Month in which intact seeds appeared ^a	Σ of seeds	Σ of intact seeds	IR
Actinidiaceae									
<i>Actinidia arguta</i>	Liana	1.53±0.10 (<i>n</i> = 10)	4	0.18	123.0±115.3	Oct, Nov	492	492	1.00
Rosaceae									
<i>Prunus</i> spp. ^b	High tree	4.54±0.37 (<i>n</i> = 10)	3	0.14	23.3±4.6	Jun	70	70	1.00
<i>Rubus</i> spp. ^c	Shrub	1.33±0.08 (<i>n</i> = 10)	1	0.05	66	Jun	66	66	1.00
Vitaceae									
<i>Vitis coignetiae</i>	Liana	4.02±0.32 (<i>n</i> = 10)	4	0.18	6.0±6.3	Oct, Nov, Dec	24	24	1.00
Stachyuraceae									
<i>Stachyurus praecox</i>	Shrub	1.48±0.26 (<i>n</i> = 10)	1	0.05	31	Jan	31	31	1.00
Moraceae									
<i>Morus bombycis</i>	Shrub	1.47±0.13 (<i>n</i> = 10)	1	0.05	484	Jun	484	484	1.00
Ebenaceae									
<i>Dyosphyros kaki</i>	High tree	5.68±0.18 (<i>n</i> = 10)	3	0.14	5.7±2.1	Nov	17	17	1.00

DE, dispersal event; DE_r, ratio of dispersal event; IR, intact rate; MCD, mean cubic diameter of seeds. ^a Names of each month are abbreviated. Months in which the number of intact seeds exceeds the annual mean are shown in bold. ^b Including *Prunus leveilleana*, *P. sagentii* and *P. grayana*. ^c Including *Rubus crataegifolius* and *R. palmatus*.

many plant species (Tables 1, 2). Thus, the role of macaques and martens as seed dispersers in Shiga Heights appeared to be greater in these seasons, during which they would likely disperse seeds of various plant species more frequently and into wider areas within the forest than they do in other seasons. In general, macaques and martens ingest large amounts of fruit across habitats [Tsuji et al., 2015, 2019] and incidentally swallow the entire fruit of many plant species without chewing, which resulted in higher IRs (Tables 1, 2). In other study sites, macaques opportunistically feed on fallen fruits on the ground in winter [Tsuji et al., 2015]. However, in Shiga Heights, snowfall reaches over 300 cm [Tsuji et al., 2015], and snow covers terrestrial food sources and decreases their availability. Thus, the period when the macaques in our study site play a role as seed dispersers seems much shorter than in other study sites in Japan. On the contrary, we found seeds from marten faeces collected even in winter, which was similar to other study sites [Tsuji et al., 2019]. This was likely due to their smaller body size and ability to climb up small branches in trees that macaques cannot access [Ohdachi et al., 2009]. Though we need more samples, the martens in Shiga Heights could play a role as dispersal agents throughout the year.

The macaques in Shiga Heights defecated seeds of 20 different species, while martens defecated only 7 species (Tables 3, 4). The results are likely due to our small number of marten samples, but also due to the variety in macaques' diet, as they feed from multiple forest strata. The seed species richness within single faecal samples (macaques, 1.9; martens, 1.4) showed no significant difference, and the number of seeds (macaques, 72.5; martens, 98.7) was also similar (except for *Actinidia arguta* and *Prunus* spp., for which martens defecated a larger number of seeds than did macaques). However, considering the macaques' group-living nature, the number of dispersed seeds would be much greater than that of solitary martens.

The vast majority of ingested seeds in our faecal samples were intact (annual mean IR = 0.98 for macaques and 1.00 for martens) (Tables 1, 2), and, therefore, the negative effects of animal ingestion on seed survival would likely not exist.

The longer dispersal distance of martens (approximately 700 m on average) compared to that of macaques [ca. 450 m on average; Tsuji et al., 2016] implied that martens would disperse seeds to locations far from the mother trees. Considering martens' behaviour to defecate in open habitats, such as forest ridges, and the higher germination ratio of marten-ingested seeds [Yasumoto and Takatsuki, 2015; Tsuji et al., 2020], the survival rate of the dispersed seeds for martens would be greater than that for macaques. This would increase its seed dispersal effectiveness. Our finding implied that sympatric mammals would contribute differently to seed dispersal.

In this study, we did not consider the relevance of other modes of dispersal: synzoochory [diaspores deliberately carried in the mouth; Yumoto et al., 1998] and epizoochory [diaspores carried on the outside; Chen et al., 2018] might be important. We also did not consider the relevance of broader community-level analyses for the interpretation of the results. Previous community-level studies in the temperate region have demonstrated differences in seed dispersal characteristics [Koike et al., 2008; Matías et al., 2008]. In order to truly evaluate the importance of primates, we need to compare dispersal parameters among sympatric frugivores in our study site, such as red fox (*Vulpes vulpes*), raccoon dog (*Nyctereutes procyonoides*), Japanese badger (*Meles anakuma*), and Asiatic black bear (*Ursus thibetanus*), and birds [Mizutani, 2017].

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Statement of Ethics

We have no ethical conflicts to disclose.

Conflict of Interest Statement

We have no conflicts of interest to declare.

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Author Contributions

Y. Tsuji wrote the manuscript; Y. Tsuji and A. Takizawa collected samples; Y. Tsuji and R. Yanti analyzed the samples; T. Hagiwara revised the manuscript.

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