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Orangutan Seed Dispersal in Gunung Palung National Park, Borneo, Indonesia: Dispersal Quantity, Germination Rates, Gut Transit Times, and Dispersal Distances

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Orangutans are large-bodied frugivores predicted to be important seed dispersers, however little is known about their seed dispersal effectiveness. To understand wild Bornean orangutan (*Pongo pygmaeus wurmbii*) seed dispersal effectiveness, we measured the quantity of seeds dispersed, and we considered the quality of dispersal by measuring germination rates of gut-passed and control seeds, gut transit times, and dispersal distances. Research was conducted in Gunung Palung National Park, Borneo, Indonesia (August 2018 to August 2019). We systematically collected orangutan fecal samples, feeding behavior, and GPS tracks during consecutive full-day focal follows. We sieved 549 fecal samples collected from 36 orangutans to count and identify seeds (>2mm). Out of the fecal samples collected, 413 (75.2%) contained seeds. A total of 24 genera were dispersed via endozoochory. Orangutan fecal samples contained a mean of 1.17 genera (range 0-7). Germination experiments were conducted with orangutan defecated seeds and seeds from fruit. A significantly higher percent of orangutan defecated seeds germinated for 5 out of 6 genera than control seeds with pulp ($p < 0.01$). A significantly higher percent of orangutan defecated seeds germinated for 3 out of 6 genera compared to control seeds without pulp ($p < 0.01$). Gut transit times in wild orangutans ranged from 39.5 to 87 hours ($n=6$). Finally, we modeled seed dispersal distances using orangutan movement tracks ($n=30$) with gut passage durations of 45 and 60 hours. Gut retention times of 45 hours resulted in a mean dispersal distance of $507 \pm 123\text{m}$ (range 69 - 1341), and 60 hours resulted in a mean distance of $592 \pm 115\text{m}$ (range 83 - 1260). We conclude orangutans are effective seed dispersers with similar efficacy to other great apes. Orangutans disperse a wide variety of genera over medium to long distances and gut passed seeds germinate at higher rates compared with controls.

Keywords: Ecology, Seed dispersal effectiveness, Movement, Tropical, Asia

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