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DISPERSAL OF FRUIT SEEDS BY BLACK BEARS

The importance of fruvigorous birds and mammals in disseminating plants has long been recognized (Darwin, 1859; Krefting and Roe, 1949). However, few attempts have been made to quantify germination of seeds from feces (Krefting and Roe, 1949; Applegate et al., 1979), despite the importance of this information for development of plant-disperser coevolutionary theory (Snow, 1971; Regal, 1977; Herrera and Jordano, 1981; Cook, 1982). Some potential dispersers of seeds destroy most of the seeds they eat (McAtee, 1905), whereas others enhance the germinability of at least some seed species (Krefting and Roe, 1949; Applegate et al., 1979). The purpose of the study reported here was to compare the germination of seeds retrieved from feces of black bears (*Ursus americanus*) with germination of seeds of ripe, uneaten fruit from northeastern Minnesota.

We observed that fruit seeds defecated by black bears are rarely broken. Black bears tend not to chew small fruits, but instead grind the pulp off the seeds in the muscular pyloric region of the stomach (Cottam et al., 1939; Rogers, unpublished data). By swallowing small fruits unchewed, black bears may increase ingestion rates for these items and may reduce chances of poisoning from seed toxins. For example, seeds of many species of *Prunus* and *Pyrus* contain cyanogenetic glycosides, such as laetrile (Kingsbury, 1964). The habits of swallowing small fruits whole and traveling long distances (up to 32 km per day [Rogers, 1977]) could make black bears particularly important dispersers of fruit seeds if enough defecated seeds germinate.

To quantity germination, 200 seeds from black bear feces and 200 ripe, uneaten fruits were collected for each of eight taxa (Table 1). Half of each sample was placed immediately on moist sphagnum in a growth chamber. The other half of each sample was refrigerated for 50 days to promote after-ripening, i.e., enzymatic processes necessary for germination in some species (Bonner et al., 1974), and then placed on moist sphagnum in a growth chamber. The growth chamber was set on an alternating cycle of 9L:15D, with temperatures of 30°C during light periods and 10°C during dark periods. Most germination took place within three weeks after placement in the growth chamber. Samples were left in the growth chamber until no further germination was observed during a week. Germinations were recorded weekly and germinated seeds or fruits were discarded to facilitate subsequent counts. For many-seeded fruits (*Amelanchier, Aralia, Rubus,* and *Vaccinium*), discarding fruits that contained some ungerminated seeds may have led to over-estimation of germination rates for uneaten fruits. Despite this, germination rates of seeds from feces were higher than those of seeds in uneaten fruits for all species under both the refrigerated and unrefrigerated treatments (Table 1). Differences were significant for five of the eight taxa.

We did not study why seeds that passed through digestive tracts tended to show higher germination rates than uneaten fruits. However, we suspect that acid scarification and mechanical scarification in the

TABLE 1.—*Percent germination of seeds in uneaten fruits versus seeds from black bear feces. Significance of differences was tested with chi-square using a 2 X 2 table.*

	Unrefrigerated		Refrigerated	
Plant taxa	Uneaten fruits	Seeds from feces	Uneaten fruits	Seeds from feces
Amelanchier spp.	9	10	12	29**
Aralia nudicaulis	27	62**	28	93**
Cornus rugosa	13	22	14	22
Cornus stolonifera	7	18*	3	22**
Prunus pennsylvanicus	22	25	35	41
Prunus virginiana	17	37**	9	26**
Rubus strigosus	14	16	19	33*
Vaccinium spp.	9[a]	15	16[a]	20

* $P < 0.05$; ** $P < 0.01$.

[a] Sample consisted of a 50:50 mixture of *Vaccinium augustifolium* and *V. myrtilloides,*

digestive tracts were responsible. Acid and mechanical scarification treatments are commonly used by horticulturists to increase germination by making seedcoats more permeable to water and gases (Bonner et al., 1974).

Within the limits of our experimental conditions, consumption of fruit by bears did not reduce germination of the seeds and appeared to increase germination in some species, suggesting that black bears could be important dispersers of fruit seeds. For very large-seeded fruits, such as plums (*Prunus nigra, P. americanus*), which were not tested but which are defecated unbroken, black bears may be one of only a few long-distance dispersal agents.

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