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Fruit harvesting by American Robins: influence of fruit size.—Size relationships between bird gape width and fruit diameter can limit the composition and breadth of avian fruit diets and the disperser assemblages of plants with vertebrate-disseminated seeds (Wheelwright 1985, Snow and Snow 1988, Lambert 1989). It is less clear, however, that birds are influenced by differences in fruit size for fruits smaller than their gape capacities. Aviary studies with tropical species suggest that birds may prefer the largest fruits they can handle (Moermond and Denslow 1983); however, results from field studies have been mixed (Wheelwright 1985, Piper 1986).

Here we examine the hypothesis that the efficiency of fruit harvest by wild American Robins (*Turdus migratorius*) in New Jersey increases with increasing fruit size. A positive relationship between feeding efficiency and fruit size would suggest a possible rationale for size preferences in fruit-eating birds. American Robins, because of their abundance, diet, and relatively large size, are among the most important consumers of fleshy fruits in eastern North America (Wheelwright 1986, White 1989).

Methods.—We examined avian fruit foraging as part of a study of the nutritional content and value of fleshy fruits for birds (White 1989). Fruit consumption by American Robins was observed September–December, 1979–1982, in old fields and mixed-aged and mature woods in central New Jersey. We recorded the plant species visited, time from robin arrival to departure from the plant in seconds, and the number of fruits eaten. Fruit widths and masses for species used by the robins were determined from plants other than those used in the observations to avoid potential biases due to selective feeding. We recorded ten or more complete foraging bouts at each of the following plant species: *Rhus copallina, Juniperus virginiana, Rosa multiflora, Vitis vulpina, Viburnum prunifolium, Lindera benzoin, Nyssa sylvatica,* and *Pyrus* sp.

Results.—Mean fruit widths ranged between 3.7–9.0 mm in diameter (mean mass: 21–518 mg); however, size limitations in feeding were not at issue because all plants had fruits 3–8 mm narrower than the mean gape width of the robin (White 1989). Significant negative correlation existed (A) between fruit width and mean number of fruits eaten in a bout and (B) between fruit width and mean bout length, while significant positive correlation existed (C) between fruit width and total fruit mass harvested per bout (Fig. 1). Results were similar

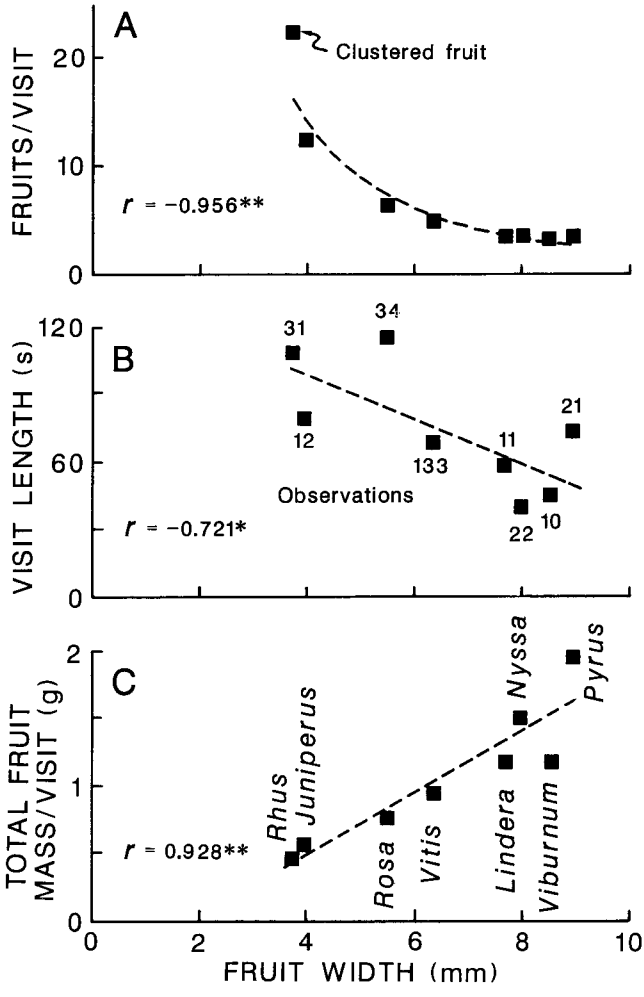

FIG. 1. Foraging by American Robins on fruits of eight woody species. A. Mean number of fruits eaten per foraging bout. Dense fruit clusters of *Rhus* sometimes allowed robins to feed easily from a single perch. The curve represents the power regression of fruits per visit on fruit width. B. Mean time spent in the fruiting plant per feeding visit. C. Total fruit mass consumed per visit calculated as the product of mean number of fruits eaten per bout and mean fruit mass. Numbers of complete foraging bouts observed are shown in Panel B.

when fruit mass instead of width was used as the independent variable ($r = -0.94$, $P < 0.01$; $r = -0.71$, $P < 0.05$; and $r = 0.98$, $P < 0.01$, respectively). Thus, robins fed on larger fruits more efficiently than smaller fruits, harvesting more biomass while swallowing fewer fruits in shorter visits.

Observation periods were not biased by fruit size. No significant correlation existed between fruit width and the time of day ($r = -0.08$, $P > 0.5$) or date ($r = -0.20$, $P > 0.5$) of observation.

From the birds' perspective, harvest efficiency may depend further on how much of the fruit is nutritive pulp and how much is non digested seeds. In the eight plant species examined here, 38–89% (mean = 31%) of wet fruit mass was pulp (White 1989). A positive relationship existed between percent pulp mass and fruit width ($r = 0.55$, $P > 0.1$); therefore, the total mass of pulp harvested per visit was also strongly positively correlated with fruit width ($r = 0.87$, $P < 0.01$).

Discussion.—Fundamental aspects of fruit harvesting by American Robins, including the number of fruits taken per visit, the length of a feeding visit to a fruiting plant, and the amount of whole fruit or pulp mass consumed per visit, were strongly associated with simple differences in fruit size. The results suggest that robins may have reason to prefer and select fruits approaching their gape capacities (cf Moermond and Denslow 1983). If size-related trends in harvest efficiency and fruit preference existed generally, the evolution of larger fruits might be favored even if enlarged fruits were available to fewer bird species because of limitations of gape size (cf Wheelwright 1985). However, the quality of seed dispersal might also vary with fruit size. If birds visit a small-fruited plant more often than a large-fruited plant to harvest an equal mass of pulp, then the spatial distribution of seeds could be more varied for the more-visited, small-fruited plant.

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