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RESEARCH NOTE

FRUITS OF ALIEN SHRUBS AND DEER MICE: A TEST OF THE PERSISTENT FRUIT DEFENSE HYPOTHESIS[1]

CHARLES E. WILLIAMS

Department of Biology
Clarion University of Pennsylvania
Clarion, PA 16214-1232

ABSTRACT

Because of extended exposure to potential seed predators and pathogens, persistent fruits of woody plants have been hypothesized to be chemically defended against biotic depredations. The "persistent fruit defense hypothesis" was tested using the deer mouse, *Peromyscus maniculatus*, in laboratory feeding trials with fruits of four alien shrubs naturalized in eastern North America: *Ligustrum vulgare* (common or European privet), *Lonicera japonica* (Japanese honeysuckle), *Lonicera maackii* (Amur honeysuckle and *Rosa multiflora* (multiflora rose). Anecdotal observations suggested potential chemical defense against small mammal predation for fruits of *Ligustrum vulgare* and *Lonicera maackii* due to toxicity and extreme pericarp bitterness, respectively. In contrast, fruits of *Lonicera japonica* and *Rosa multiflora* are known to be readily eaten by small mammals and so apparently lack chemical defense. It was hypothesized that levels of deer mouse consumption of fruits and the seeds within would be lowest in *Ligustrum vulgare* and *Lonicera maackii* due to defensive unpalatability and greatest in non-defended *Lonicera japonica* and *Rosa multiflora*. Deer mice readily extracted and consumed seeds from persistent fruits of *Ligustrum vulgare*, *Lonicera japonica*, *Lonicera maackii* and *Rosa multiflora* at comparable levels during most feeding trials and generally showed no distinct preference for, or aversion to, fruits of any species. Thus, the persistent fruit defense hypothesis was not supported for fruits of these alien shrubs under laboratory conditions.
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INTRODUCTION

Fruit nutritive quality in autumn-ripening, fleshy-fruited woody plants of the eastern United States broadly conforms to one of two categories (Stiles 1980). High-quality fall fruits are rich in pericarp nutrients such as carbohydrates, proteins, and especially lipids; low-quality fall fruits contain nominal nutrient levels. Stiles (1980)

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were presented (total 40 fruits/petri plate). Food was removed from mouse cages 2 hours before feeding trials were initiated. Feeding trials lasted for 2 hours and were conducted between 1900 and 2100 hours on three successive days. The order of feeding trials was randomized such that each mouse (n = 6) received a different treatment on each of the three days of the study. At the conclusion of each trial, all remaining intact fruits and fruit and seed fragments were collected. A fruit was scored as eaten if the majority (≥ 95%) of seeds within the fruit was consumed by a mouse and the fruit rendered non-viable (i.e., unlikely to be eaten by an avian seed disperser or contain intact seeds) by the feeding damage.

Differences in fruit and seed characteristics among shrub species were examined by one-way analysis of variance. Duncan's multiple range test was used to separate means when ANOVAs were significant (Zar 1996). Fisher's exact test was used to determine if fruits of individual shrub species were eaten to a greater or lesser extent than the fruit population as a whole, summed across mice, for each feeding trial (Zar 1996). For all analyses, significance was accepted at $P \leq 0.05$.

RESULTS

Fruit and seed characteristics for each of the four shrub species are shown in Table 1. Species differed significantly in average fruit weight (one-way ANOVA, df = 3, F = 59.7, P < 0.0001) and in mean number of seeds per fruit (one-way ANOVA, df = 3, F = 178.9, P < 0.0001). *Lonicera maackii* had the heaviest fruit, followed by *Rosa multiflora*, *Lonicera japonica* and *Ligustrum vulgare*. The greatest number of seeds per fruit occurred in *Rosa multiflora* (more precisely achenes, but for ease of discussion diaspores of all species will be called seeds), followed by *Lonicera japonica, Lonicera maackii* and *Ligustrum vulgare*. Mean individual seed weight differed significantly among species (one-way ANOVA, df = 3, F = 257.3, P < 0.0001). Fruits of *Ligustrum vulgare* and *Rosa multiflora* contained the heaviest seeds; seeds of *Lonicera maackii* and *Lonicera japonica* were lightest and similar in weight. Pulp to seed ratio was greatest in *Lonicera maackii* and *Lonicera japonica*. The general character of the fruit pulp also varied among species. The fruit pulp of both *Lonicera maackii* and *Lonicera japonica* was watery and somewhat viscid; *Ligustrum vulgare* fruit pulp was dry and mealy. No appreciable pulp occurred in fruits of *Rosa multiflora*; only the thickened wall of the floral cup surrounded the achenes of this species.

In no choice feeding trials, fruits of each alien shrub species were eaten in similar proportion ($P > 0.05$) to the total fruit population; thus deer mice showed no significant preference for, or aversion to, fruit of any particular species (Table 2). In general, greater than 50% of fruits of each species presented to mice were consumed during no choice trials. In fruits of *Lonicera maackii* and *Lonicera japonica*, mice typically bit into the pericarp at a single location and then extracted and ate the seeds. Variable amounts of the viscid *Lonicera* fruit pulp were also eaten, perhaps unavoidably since seed extraction required some handling and ingestion of pulp. Very little of the fruit pulp of *Ligustrum vulgare* was consumed by mice but the large seeds were eaten after pericarp removal. Both the achenes and the wall of the floral cup of *Rosa multiflora* were consumed by mice.

Fruits of each alien shrub species were eaten in similar proportion ($P > 0.05$) to the total fruit population in the low density choice trial (Table 2). The proportion of fruits consumed by species in the low density choice trial ranged from 56.6 to 70.0%. The overall proportion of fruits consumed by mice in the low density choice trial was similar to that observed across single species no choice trials (Table 2).

In the high density choice trial, fruits of *Ligustrum vulgare* were eaten in significantly lower proportion ($P < 0.001$) than the total fruit population (Table 2). However, fruits of the remaining three shrub species were eaten in similar proportion ($P > 0.05$) to the total fruit population. The overall proportion of fruits eaten during the high density choice trial was lower than that for both no choice and low density choice feeding trials (Table 2), probably because the fruit density exposed to mice was twice that in the high density trial than in the other feeding trials.

TABLE 1. Fruit and seed characteristics for alien shrubs used in deer mouse feeding trials (where relevant, values are means ± 1 SE). Means bearing the same letter do not differ significantly (one-way ANOVA followed by Duncan's multiple range test, $P \leq 0.05$).

	Alien shrub species			
Fruit parameter	*Lonicera maackii*	*Lonicera japonica*	*Ligustrum vulgare*	*Rosa multiflora*
Average fruit weight (g)	0.18 ± 0.01a	0.12 ± 0.01b	0.10 ± 0.003c	0.16 ± 0.01d
Average seed weight (g)	0.005 ± 0.001a	0.003 ± 0.002a	0.03 ± 0.001b	0.008 ± 0.001c
Average number of seeds/fruit	3.8 ± 0.1a	6.2 ± 0.4b	1.1 ± 0.02c	7.9 ± 0.2d
Pulp to seed ratio	8.5	4.9	2.2	1.5
Fruit type	berry	berry	drupe	fleshy floral cup
Fruit color	red	black	blue-black	red

Borowicz, V.A. 1988a. Fruit consumption by birds in relation to fat content of pulp. Am. Midl. Nat. 119:121-127.

Borowicz, V.A. 1988b. Pulp composition and the invasion and decay of fruits by microbes. Can. J. Bot. 66:1068-1072.

Borowicz, V.A. 1988c. Do vertebrates reject decaying fruit? An experimental test with *Cornus amomum* fruits. Oikos 53:74-78.

Gleason, H.A. and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. 2nd ed. The New York Botanical Garden. Bronx, NY. 910 p.

Ingold, J.L. and M.J. Craycraft. 1983. Avian frugivory on honeysuckle (*Lonicera*) in southwestern Ohio in fall. Ohio J. Sci. 83:256-258.

Johnson, R.A., M.F. Willson, J.N. Thompson and R.I. Bertin. 1985. Nutritional values of wild fruits and consumption by migrant frugivorous birds. Ecology 66:819-827.

Jones, E. and N.T. Wheelwright. 1987. Seasonal changes in the fruits of *Viburnum opulus*, a fleshy-fruited temperate-zone shrub. Can. J. Bot. 65:2291-2296.

Krefting, L.W. and E.I. Roe. 1949. The role of some birds and mammals in seed germination. Ecol. Monogr. 19:270-286.

Martin, A.C., H.S. Zim and A.L. Nelson. 1951. American wildlife and plants: a guide to wildlife food habits. Dover Publ., Inc. New York. 500 p.

McDonnell, M.J., E.W. Stiles, G.P. Cheplick and J.J. Armesto. 1984. Bird-dispersal of *Phytolacca americana* L. and the influence of fruit removal on subsequent fruit development. Amer. J. Bot. 71:895-901.

Mittelbach, G.G. and K.L. Gross. 1984. Experimental studies of seed predation in old fields. Oecologia 65:7-13.

Muenscher, W.C. 1975. Poisonous plants of the United States. Revised ed. Macmillan Publ. Co., Inc. New York. 277 p.

Randall, J.M. and J. Marinelli (eds.). 1996. Invasive plants: weeds of the global garden. Brooklyn Botanic Garden. Brooklyn, NY. 111 p.

Schiffman, P.M. 1997. Animal-mediated dispersal and disturbance: driving forces behind alien plant naturalization. pp. 87-94. *In* J.O. Luken and J.M. Thieret (eds.), Assessment and management of plant invasions. Springer-Verlag. New York. 324 p.

Schopmeyer, C.S. (tech. coord.). 1974. Seeds of woody plants in the United States. USDA Forest Service Agric. Handbook 450. 883 p.

Smith, C.F. and S.E. Aldous. 1947. The influence of birds and mammals in retarding artificial and natural reseeding of coniferous forests in the United States. J. For. 45:361-369.

Stiles, E.W. 1980. Pattern of fruit presentation and seed dispersal in bird-disseminated woody plants in the eastern deciduous forest. Am. Nat. 116:670-688.

Stiles, E.W. 1982. Expansions of mockingbird and multiflora rose in the northeastern United States and Canada. Am. Birds 36:358-364.

Vereshchagin, A.L., E.V. Anikina, A.I. Syrchina, M.F. Lapin, L.A. Azin and A.A. Semenov. 1989. Chemical investigation of the bitter substances of the fruit of *Lonicera caerulea*. Chemistry of Natural Compounds 25:289-292.

Williams, C.E. 1996. Alien plant invasions and forest ecosystem integrity: A review. pp. 169-185. *In* S.K. Majumdar, E.W. Miller, and F.J. Brenner (eds.), Forests– A global perspective. Pennsylvania Academy of Science. Easton, PA.

Wolff, J.O. and B. Hurlbutt. 1982. Day refuges of *Peromyscus leucopus* and *P. maniculatus*. J. Mammalogy 63:666-668.

Zar, J.H. 1996. Biostatistical analysis. 3rd ed. Prentice-Hall, Inc. Englewood Cliffs, NJ. 662 p. and appendices.