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Consumption of Seeds of the Invasive Amur Honeysuckle, *Lonicera maackii* (Rupr.) Maxim., by Small Mammals

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ABSTRACT: Small mammals are important consumers of seeds and fruits of native woody plants in many natural areas and other managed lands, but little is known of their interactions with exotic shrubs. We examined the role of small mammals as consumers of seeds of the invasive Amur honeysuckle, *Lonicera maackii* (Rupr.) Maxim., in southwestern Ohio to determine (1) if the bitter-tasting fruit pericarp of *L. maackii* discourages small mammals, and (2) if small mammals are significant consumers of the seeds within fallen fruits of *L. maackii*. In laboratory feeding bioassays, seed eating by deer mice (*Peromyscus maniculatus*) was not deterred by the bitter fruit pericarp; mice removed and ate seeds from over 63% of *L. maackii* fruits presented. In the field, overall survival rates of *L. maackii* fruits and seeds ranged from 84% to 88%, but the number of fruits removed or eaten did not differ significantly among forest interior, forest edge, or wooded corridor habitats. Trapping evidence suggests that *P. maniculatus* was the major small mammal consumer of fruits and seeds of *L. maackii*. We conclude that (1) small mammals are unlikely to influence seed survival of *L. maackii*, and (2) removal of *L. maackii* and other similar exotic shrubs is unlikely to affect population dynamics of small mammals.

INTRODUCTION

Amur honeysuckle, *Lonicera maackii* (Rupr.) Maxim., is one of several exotic bush honeysuckles that are rapidly spreading through landscapes of the eastern United States and Canada (Braun 1969, Pringle 1973, Ingold and Craycraft 1983, Harvill et al. 1986, Luken 1988, Carter et al. 1990). An invader of both forests and open habitats (Luken 1988, 1990; Luken and Mattimiro 1991), *L. maackii* produces red, fleshy berries in great abundance, and over 20 species of frugivorous birds disperse its seeds (Schopmeyer 1974, Ingold and Craycraft 1983, Field and Mitchell 1988). Once established, *L. maackii* populations are primarily maintained by vegetative sprouting (Luken 1988, 1990; Luken and Mattimiro 1991) although recruitment from short-lived soil seed banks may occur following disturbance (Schwegman and Glass 1986, Luken and Mattimiro 1991). *L. maackii* is a major threat to the integrity of forest communities that it invades: regeneration of forest trees is significantly impeded by the development of shrub strata dominated by *L. maackii* (Luken 1990).

The impact of frugivorous and seed-eating small mammals on fruit and seed survival of *L. maackii* is poorly known. Small mammals are known to feed on young stems of *L. maackii* (Field and Mitchell 1988), but seed consumption by small mammals has not been reported. The fruit pericarp of *L. maackii* is extremely bitter in taste and low in nutrients (Ingold and Craycraft 1983) and may be unpalatable or unattractive to small mammals; thus seeds within fruits of *L. maackii* could escape mammalian seed consumers. Distasteful chemicals or toxins in the fruit pericarp of some bird-dispersed native plants apparently protect seeds from mammalian consumers such as white-footed mice, *Peromyscus leucopus* (McDonnell et al. 1984); however, the "defensive unpalatability" of fruits of exotic shrubs to native small mammals has not been demonstrated.

We examined the role of small mammals as consumers of fruits and seeds of *L. maackii* to determine (1) whether the bitter-tasting fruit pericarp discourages seed eating by small mammals, and (2) whether small mammals are significant consumers of the seeds within fallen fruits of *L. maackii* in the field . As a secondary objective, we examined the influence of habitat on consumption of *L. maackii* seeds. *L. maackii* bears larger fruit crops in forest edges and wooded corridors than it does in the interior of forests (Luken 1988, Luken and Mattimiro 1991) and small mammal activity, including seed consumption, is often highest in edges and corridors (Wegner and Merriam 1979, Sork 1983, Yahner 1983, Henderson et al. 1985, Webb and Willson 1985). Thus we hypothesized that the relative levels of small mammal consumption of seeds of *L. maackii* would be wooded corridor ≥ forest edge ≥ forest interior.

Our field studies focused on seeds within fallen fruits since fallen *L. maackii* fruits are easily accessible to small mammals, the "fruit rain" beneath *L. maackii* plants can be extensive (Luken and Mattimiro 1991, C.E. Williams pers. obs.), and intact fruits could contribute substantially to the soil seed bank (Luken and Mattimiro 1991). Recruitment from soil seed banks can occur following control efforts for *L. maackii*, particularly clipping, shrub removal, and prescribed burning (Schwegman and Glass 1986, Luken 1990, Luken and Mattimiro 1991). Postdispersal seed consumption can significantly reduce survival of seeds in some other species (e.g., Kelly and Parker 1990). An understanding of the impact of small mammal seed consumption on *L. maackii* seed survival, in conjunction with knowledge of habitat-specific variations in soil seed bank size (see Luken and Mattimiro 1991), would be useful to natural areas managers engaged in control efforts for this invasive species.

METHODS

Fruits of *L. maackii* were collected during mid-November 1990 from shrubs growing at the Miami University Ecology Research Center (ERC), Butler County, southwestern Ohio, for use in small mammal feeding bioassays. *L. maackii* is widespread in this area (Braun 1969, Luken 1987), particularly in the understory stratum of forests and wooded corridors. Fruits were collected from ten shrubs and pooled and refrigerated until feeding studies began (not longer than 24 hours).

Six adult *P. maniculatus* were live-trapped from old fields at the ERC during late October. Mice were housed in individual 28-cm by 22-cm by 22-cm cages in an environmental room (12 h:12 h light:dark cycle, at 21°C), supplied with water and rat chow ad libitum (including during feeding trials), and acclimated to captivity for at least two weeks prior to feeding studies.

Feeding bioassays were initiated by presenting twenty ripe *L. maackii* fruits, contained in a plastic petri plate, to each mouse. Assays continued for two hours and were conducted between 1900 and 2100 hours, an active period for the largely nocturnal *Peromyscus* (Semel and Andersen 1988). At the conclusion of the feeding trial, all remaining fruits and fruit and seed fragments were collected from cages.

Field studies were conducted at the ERC from early October to mid-December 1990. The ERC consists of a mosaic of forest patches and corridors, old fields, and croplands typical of the agriculturally dominated Midwest. The interior and edges of a 5-ha forest and three adjacent but noncontiguous wooded corridors (ranging from 150 to 200 m in length and 2 to 10 m in width) were selected for study. *Acer saccharum* Marsh. (sugar maple), *Gleditsia triacanthos* L. (honeylocust), *Maclura pomifera* (Raf.) Schneid. (Osage orange), *Quercus alba* L. (white oak), and *Q. rubra* L. (northern red oak) were the major tree species at the forest edges and interior; *G. triacanthos* and *M. pomifera* comprised the tree stratum of the wooded corridors. *L. maackii* dominated the shrub stratum of all sites.

Three 50-m-long transects were established in each of the three habitats. Forest interior transects were located at the approximate center of the wooded area, separated by 75 to 100 m and parallel in orientation. Forest edge transects were located 2 m in from the forest periphery and along the north, east, and south borders of the forest. Wooded corridor transects were located at the center of each corridor, parallel to the corridor length.

Plastic petri plates (n = 10/transect) containing soil and leaf litter from respective habitats were positioned at 5-m intervals along each transect. Five ripe, freshly collected *L. maackii* fruits were placed in each petri plate weekly (a total of 150 fruits/habitat/week). The number and condition of fruits remaining in petri plates and within a 20-cm radius of the plates was recorded after 24 hours (the search area was cleared of all fruits prior to petri plate placement); all intact fruits and fruit and seed fragments were removed from plates.

To identify potential small mammal consumers of fallen *L. maackii* fruits, Sherman live traps baited with fruits of *L. maackii* were randomly set along each transect (see Webb and Willson 1985). Traps were set for three nights during late November and mid-December (a total of 45 trap nights/habitat).

RESULTS

Captive *P. maniculatus* readily extracted and consumed seeds from fruits of *L. maackii* during laboratory feeding bioassays. The seed contents of 63.5% of fruits presented to mice were eaten, an average of 12.7 fruits per mouse. Mice typically bit into the fruit pericarp at a single location and then extracted and ate the seeds. All sound seeds within fruits selected by mice were eaten as were small quantities of the mucilaginous *L. maackii* fruit pulp. Given an average of 3.8 seeds per fruit (based on a dissected subsample of ERC fruit, n = 100 fruits), each mouse consumed an estimated 48 *L. maackii* seeds during the two-hour feeding period.

Survival of *L. maackii* fruits in the field did not differ significantly among forest interior, forest edge, or wooded corridor transects (Kruskal-Wallis test, H = 2.25, df = 2, $P = 0.32$). Fruit survival (Table 1, Figure 1) was generally lowest for forest edge and wooded corridor transects, especially during early November. Feeding damage observed in *L. maackii* fruits in the field was identical to that caused by *P. maniculatus* in laboratory feeding bioassays.

Table 1. Results of *Lonicera maackii* fruit removal studies. Overall fruit survival is the grand mean of weekly survival rates of intact fruits by habitat for the study.

Habitat	Overall $\bar{X}$ (± 1 SE) fruit survival (%)	Range of survivorship during study (%)
Forest interior	87.8 ± 2.4	71.3– 95.3
Forest edge	84.1 ± 3.8	56.0– 97.3
Wooded corridor	87.2 ± 3.0	66.7–100.0

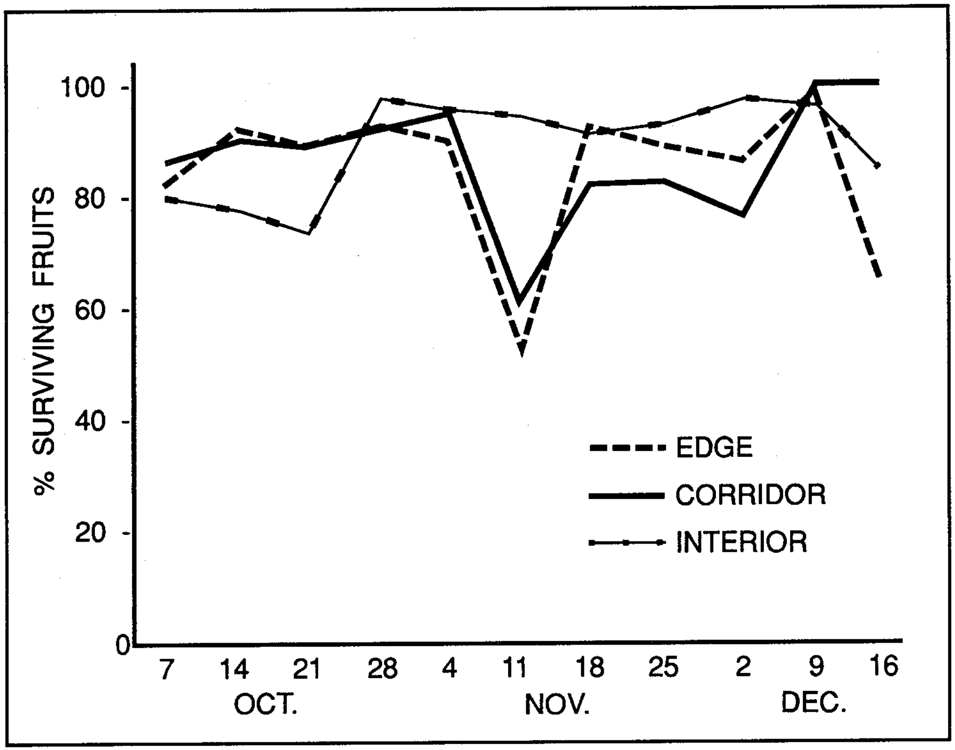

Figure 1. Mean survivorship of fruits of *Lonicera maackii* placed along habitat transects.

A total of 14 small mammals of two species was captured in live traps baited with *L. maackii* fruits: 13 *P. maniculatus* and 1 *P. leucopus*. Of the total *P. maniculatus* captured, 6 were captured in wooded corridors, 5 in forest edges, and 2 on forest interior transects. The *P. leucopus* was captured on a forest edge transect. Overall, small mammal trapping success (number of captures per total number of trap nights) was the same for forest edge and wooded corridor transects (13%) but lower for the forest interior (4%).

DISCUSSION

In laboratory feeding bioassays and in field studies, *P. maniculatus* readily extracted and consumed seeds from fruits of *L. maackii*. Thus we conclude that fruits of *L. mackii* are not distasteful or toxic to small mammals or at least not to *P. maniculatus*.

An average of 12–15% of *L. maackii* fruits and their seed contents were removed or eaten during our field studies after one day, an observation comparable to values reported by Jones and Wheelwright (1987) for seeds within fallen fruits of the exotic shrub *Viburnum opulus* L. in New York. Because our study was conducted during only half of the potential fruiting period of *L. maackii* (Field and Mitchell 1988), and fruit quality and palatability to vertebrates may change during the season (Jones and Wheelwright 1987), it is possible that our results would have differed if studies were performed in late winter or early spring, particularly during the period of *L. maackii* fruit decay. However, mammalian seed consumers like *Peromyscus* are not deterred from extracting and feeding on seeds from decaying fleshy fruits (Borowicz 1988). Use of *L. maackii* fruits by small mammals probably is influenced more by the seasonal availability of preferred alternate foods such as oak mast (e.g., Briggs and Smith 1989) that are of higher nutritional quality and, generally, more abundant (Stiles 1980, Jones and Wheelwright 1987). The fall of 1990 was a poor mast year for the majority of fagaceous trees (trees in the Fagaceae, most of which produce nuts, e.g., beech, oak) at the ERC (C.E. Williams pers. obs.).

We did not detect a habitat effect on the consumption or removal of *L. maackii* fruits as we had hypothesized. In studies showing a strong correlation of habitat with seed removal (Mittelbach and Gross 1984, Webb and Willson 1985, Kikuzawa 1988), the habitats examined contrasted greatly in disturbance regimes and in the composition and structure of vegetation (e.g., fields versus forests, vegetated sites versus plowed soil). In comparison, the habitats we selected — forest edge, forest interior, and wooded corridor — which are representative of the major habitats occupied by *L. maackii* in southwestern Ohio, were not differentially disturbed nor did they diverge greatly in vegetational structure (i.e., all habitats were dominated by well-developed arboreal vegetation). In fact, small mammal activity and mammalian seed consumption is generally highest in habitats with greater cover (Rosenzweig 1973, Mittelbach and Gross 1984, Kikuzawa 1988, Simonetti 1989). Thus, our inability to detect a habitat effect on seed consumption and removal of *L. maackii* fruits may be explained in part by the lack of strong contrast among the wooded habitats we studied and, perhaps, by the likelihood of similar small mammal activity throughout the three habitats we studied. Although our data set was small, small mammal trapping success was comparable among habitats.

The potential impact of small mammals on seed survival of *L. maackii* in southwestern Ohio appears to be minimal, particularly in light of the tremendous fruit crops produced by this species (see Ingold and Craycraft 1983). We surmise that small mammals are unlikely to greatly influence the population dynamics of *L. maackii* populations, including the extent and distribution of temporary soil seed banks. Our results also suggest that, given the apparent low use of *L. maackii* seeds as food by small mammals, control efforts for *L. maackii*, such as clipping or shrub removal, would generally have little impact on small mammal populations. Experimental evidence from other studies supports this inference: manipulative experiments conducted in the western United States found that declines of shrub-related food resources following shrub removal generally had no effect on the population dynamics of *P. maniculatus* and other small mammals (Parmenter and MacMahon 1983). However, eradication of introduced shrubs could affect small mammal dispersion patterns through a perception of increased predation risk (Simonetti 1989), and this could influence spatial patterns of postdispersal seed consumption. Furthermore, total eradication of shrubs could have negative effects on shrub-nesting bird species (Whelan and Dilger 1992), especially if native shrubs are not present at the time of eradication. We suggest that natural areas managers evaluate concerns such as these when considering schedules for removal of invasive, exotic shrubs.

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