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## SHORT COMMUNICATION

# Space-dependent effects of floral abundance on flower visitors

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Previous studies have shown that floral abundance is an important trait to attract flower visitors. However, few studies considered the spatial effects of flower abundance on flower visitors. In this paper, we examined and discussed the relationship between floral abundance and number of flower visitors in three spatial scales.

**Keywords:** pollination; floral abundance; space-dependent effect; flower visitor

An important question in pollination ecology is which floral traits attracts flower visitors (Thomson 1988). Previous studies have shown that flower number is an important trait in increasing the insect pollinators on flowers (e.g. Willson and Rathcke 1974; Willson and Price 1977; Davis 1981; Schmitt 1983; Conner 1996). However, these studies have given little consideration to spatial scales, and therefore the spatial effect of floral attractiveness in terms of floral abundance on flower visitors is largely unexplored (but see, Thomson 1981; Schmitt 1983; Kunin 1997).

To determine the effect of different spatial scales of floral abundance on the number of flower visitors, we examined the relationship between floral abundance and number of flower visitors in three spatial scales at a site near Duluth, MN, USA in August 2010. In the small scale ($0.5 \times 0.5$ m area), we compared the number of flower visitors on two adjacent plants (seven pairs) with different floral

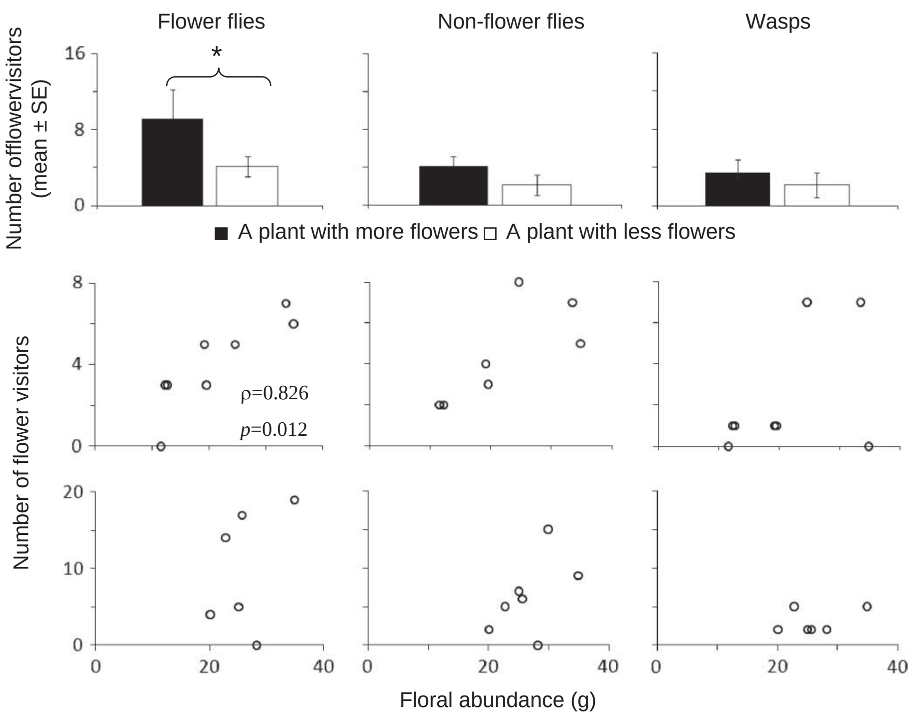


Figure 1. Top: number of flower visitors on plants with more and less flowers in the small scale. Vertical bars show mean ± SE. NS = $*p < 0.05$. Middle: The relationship between number of flower visitors and floral abundance in the middle scale. Bottom: The relationship between number of flower visitors and floral abundance in the large scale.

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abundance. We examined whether number of flower visitors was dependent on floral abundance in a middle scale (5 × 5 m area) using randomly selected eight flowering plants, and in a large scale (50 × 50 m area), using randomly selected eight pairs of flowering plants. We counted the number of flower visitors on individual plants in three times of 9:30–12:00 am, 13:30–15:30 pm, and 16:30–18:00 pm on 23, 24, and 26 August 2010. Then all of the inflorescence from each plant were collected and weighed in the laboratory. We used the weight of inflorescence as an index of the floral abundance. Flower visitors were classified into four taxonomic groups: flower flies (Syrphidae), non-flower flies, wasps, and others. The number of flower visitors on the paired plants in the small scale was tested using Wilcoxon signed rank test. The relationships between number of flower visitors and floral abundance in the middle and in the large scales were examined using Spearman's rank correlation.

We found that total 321 flower visitors consisted of: 39% flower flies, 26% non-flower flies, 18% wasps, and 17% others. In the small scale, the number of flower flies on plants with more floral abundance was greater than less flowered plants ($p = 0.036$, $T = 21$, Figure 1). In the middle scale, the number of flower flies was significantly correlated with floral abundance ($\rho = 0.826$, $p = 0.012$), but there was no significant correlation in the large scale ($p > 0.05$). Our results suggest that visitation number of flower flies increases with floral abundance within relatively small area (less than 25 $m^2$), but not large area (2500 $m^2$). Neither wasps nor non-flower flies significantly responded to floral abundance in any of these spatial scales ($p > 0.05$). This is probably because these flower visitors do not feed exclusively on flower nectar and/or pollen, but feed on other food sources, such as caterpillar, rotting meat, and feces (Hahn 2009).



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