Using flower morphology to predict pollinator types

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Abstract: Many flowering plants have developed floral morphologies that we commonly assume to be associated with particular types of pollinators. We specifically looked at flower morphologies associated with hummingbirds and insects. We tested these assumptions by recording visits by all pollinator types. We found the assumptions were consistent with our observations. Surprisingly, species with non-specific flower morphologies seemed to attract as many birds and insects as flowers with more specialized morphologies. Studies controlling for number of flowers are needed to confirm this observation.

Key Words: flower visitation, hummingbird, insect

INTRODUCTION

Most tropical plants rely on animal pollinators, such as insects, birds, or bats (Baker et al. 1983). Flowering plants have developed a variety of strategies to attract pollinators. Based on many anecdotal observations and some quantitative analyses, suites of flower characteristics, such as shape, color, and odor, seem to be reliably associated with particular pollinator types. We tested some common assumptions associating pollinator type with particular flower morphologies: red tubular flowers with hummingbirds; large, blue composite flowers and yellow bilabiate flowers with insects; and small, pink and purple flowers with open corollas with both pollinator types. We predicted that the "non-specific flowers" associated with both birds and insects would be visited less frequently by birds than the "hummingbird flowers" and less frequently by insects than the "insect flowers". We predicted that the other two flower groups would be visited frequently and almost exclusively by one pollinator type.

Because nectar sugar concentration also tends to vary predictably among pollinator types (Baker et al. 1983), sugar concentration is often assumed to differ in particular ways among distinct flower morphologies. We planned to test these assumptions as well. However, we had difficulty in extracting nectar from some flowers, and, due to technical difficulties, we had low confidence in our measures of sugar concentration. We will not refer to this component of our study in the remainder of the paper.

METHODS

We conducted our field study between 07:30 and 09:30 on 27 - 28 January 2003 at the Cuerici Biological Station on a 1 km stretch of trail northeast of the station. We haphazardly selected 4 plants each of 6 different plant species, attempting to choose plants that represented a range of microhabitat and environmental conditions (surrounding plant density and diversity, and level of sunlight).

As classic "hummingbird flowers" with long, red, tubular corollas, we chose *Bomarea costaricensis* (Amaryllidaceae) and a locally common but unidentified species of Acanthaceae. As classic "insect flowers", we chose *Hemichaema fruticosa* (Scrophularaceae) with yellow bilabiate corollas and *Dahlia* spp. (Asteraceae) with large, blue, composite flowers. As "non-specific flowers", not associated with any one pollinator type, we chose *Monochaetum* spp. (Melastomataceae) and *Fuchsia* spp. (Onagraceae) with small pink and purple flowers with open corollas or short corolla tubes.

On both days, we observed each plant for 15 minutes (for a total of 16 h of observation time) and recorded the fre-

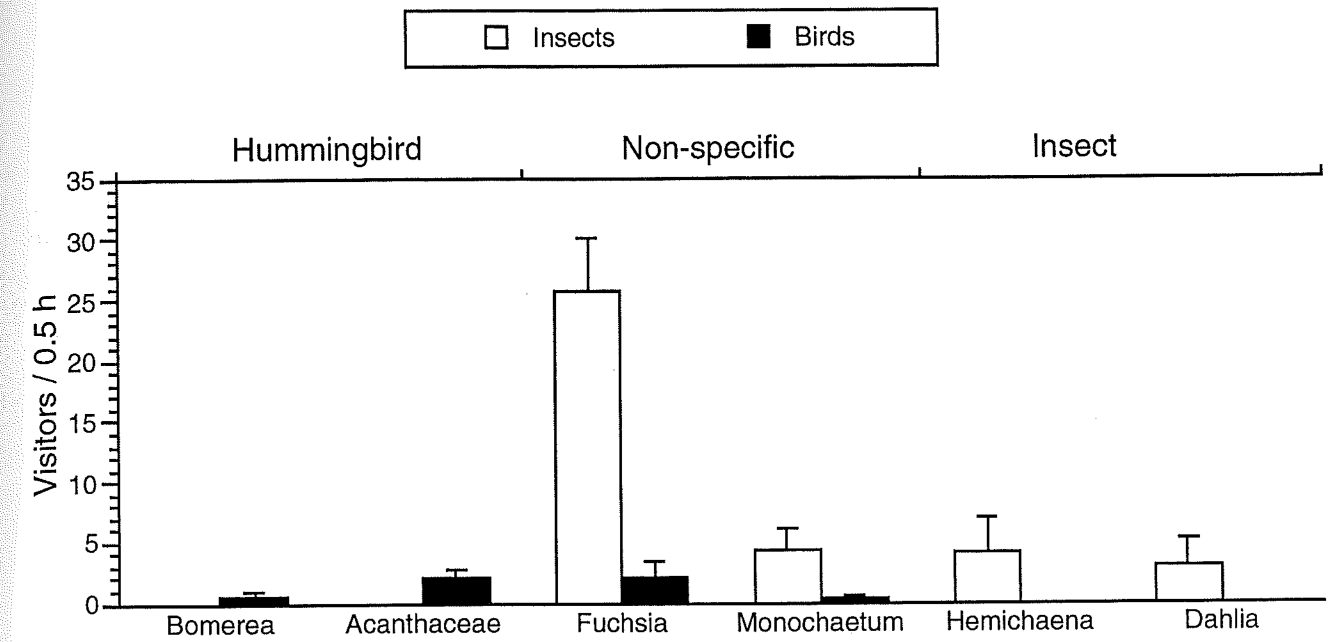

FIG. 1. Number (mean ± SE) of insect and bird visitors per 0.5 h for each flower genus for some of the most common species in the disturbed areas of the Cuerici Preserve, Costa Rica. Values are visits per plant (n = 4).

quency and identity of visitors. We defined a visit as an active probing of the flower. Visitors were classified as either insect or hummingbird. Insect visitors were all Hymenoptera (bees) or Lepidoptera. Observers synchronized viewing periods so that one plant of each pollinator type was being observed during each 15 minute time interval.

RESULTS

The classic assumptions regarding flower morphologies were consistent with our observations for the species we examined. All 10 visitors to hummingbird flowers were hummingbirds, and all 56 visitors to insect flowers were insects. However, some results were unexpected. Hummingbirds visited the non-specific flowers as frequently as the classic hummingbird flowers, with mean values, expressed as visits/plant/0.5 h ± SE, of 1.13 ± 0.72 and 1.25 ± 0.53, respectively (Fig. 1). Insects visited the non-specific flowers significantly more than the classic insect flowers, with mean values in visits/plant/0.5 h ± SE of 17.1 ± 3.93 and 7.0 ± 1.76, respectively (Fig. 1; $t = -2.35$, $df = 14$, $P = 0.03$). Consequently, the non-specific flower type had 80 more total visits than either of the specialized flower types combined. The proportion of bird to insect visitors differed significantly between plant morphologies (Fig. 1; $F = 12.8$, $df = 2, 21$, $P < 0.001$).

DISCUSSION

Our field observations of pollinator visits confirmed common assumptions based on flower morphologies. Unexpectedly, non-specific flowers were visited by insects more often than insect flowers and by hummingbirds as frequently as hummingbird flowers. Thus, when non-specific flower species are abundant, pollinator efficiency for the more specialized flower species may be reduced.

While we did not measure flower abundance, it appeared that hummingbird and insect flowers had lower flower densities than non-specific plants. This may explain the high overall visitation rate to non-specific flowers. We suggest that future studies quantify visitation rate per flower, to more rigorously compare the ability of different flower morphologies to attract pollinators of various kinds. It would also be useful to assess the out-crossing potential of visits by different pollinator types by quantifying how frequently they move among conspecific, rather than heterospecific flowers.

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