Estimating pollination success with artificial flowers

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Investigators of the interactions between plants and pollinating animals have frequently resorted to artificial flowers to clarify aspects of pollinator preferences and choice-making. Such experiments typically present animals with arrays of multiple phenotypes of "flowers" constructed to vary in particular characters; animals' responses are measured as the visitation rates to the different floral phenotypes. Such experiments clearly establish behavioural responses by the animals, but extrapolating from effects on visitation to effects on plant reproductive success requires additional assumptions that are hard to test. To provide response variables that are more directly related to pollen transfer, we devised artificial flowers that dispense and receive powdered food dyes (pollen analogs) as bumble bees visit them. The cumulative amounts of dye delivered by "male" flowers to "female" flowers during long foraging bouts by many bees are easily quantified by dissolving the dye-laden "stigmas" in water and measuring the absorbances of the coloured solutions by spectrophotometry. This general technique has promise for investigating long-standing questions in pollination ecology, especially because one can in principle measure not only "female success," as dye receipt, but also compare the "male success" of two floral phenotypes by having them offer different colours of dye. In this primarily methodological paper, we describe the construction and use of the flowers, but also present data from pilot experiments that demonstrate the utility of the technique for examining the effects of different nectar concentrations on dye receipt by female flowers. Rich flowers offering 30% sucrose received more dye than poor flowers offering 10% sucrose, even when the two types were spatially intermingled in checkerboard style. When the two types were spatially aggregated to form larger rich and poor patches, the dye-donation advantage of rich flowers increased with patch size. We hypothesize that the rich-nectar advantage in intermingled flowers depends largely on bees making longer visits to rich flowers; as patch size increases, additional advantages arise because bees are better able to remember the locations of rich patches, and therefore make more visits. The dye method integrates both of these effects in a way that simply counting visits could not.

A bumble bee visiting an artificial flower