

## Ant mimicry by *Passiflora* flowers?

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### ABSTRACT

Mutualism between plants and the ants that defend them from herbivory is a well-known phenomenon. Because of ant aggression, ant mimicry as a defense against predation is very common in the animal kingdom, and has already been suggested as a type of visual anti-herbivory defensive coloration in leaves and stems of several plant species. Many *Passiflora* species have dark dots and short stripes on their flowers that visually (to the human eye) mimic ants or aphids. We present a new, third type of suggested arthropod mimicry that adds to the previous suggestions of defensive *Passiflora* butterfly-egg mimicry and caterpillar mimicry. It is contended that this type of Batesian ant mimicry may protect *Passiflora* flowers from herbivory.

**KEYWORDS:** Ant mimicry, aphid mimicry, defense, flower, herbivory, *Passiflora*

### INTRODUCTION

Most studies of plants that mimic animals have focused on mimicry types that serve pollination (Wickler, 1968). The best-known case is of bee mimicry by orchid flowers of the genus *Ophrys*, which resemble bees in size, shape, and odor, thus attracting male bees to pollinate them (Schiestl et al., 2000). While many accept the *Ophrys* mimicry hypothesis, the bee-mimicking signals can also be considered a different type of deception based on the exploitation of perceptual biases in animals (Schaefer and Ruxton, 2009). Whether a signal or an exploitation of perceptual biases, the deception works and attracts sufficient pollination, indicating that animal mimicry can be beneficial to plants.

In one of the most important essays on plant mimicry, Wiens (1978) stated that defense by means of predator mimicry as found in animals is not likely to be found in plants. Although the evidence listed below contradicts that statement, the role of defensive, anti-herbivory animal mimicry by plants has received very little, and partly anecdotal, attention. Only a few cases of defensive animal mimicry by plants have been suggested to occur, and these were usually not studied experimentally. The suggested types of defensive animal mimicry by plants belong to two general types—direct animal mimicry and mimicry of cues for animal action—and are manifested in several forms: (1) insect

egg mimicry (Benson et al., 1975; Shapiro, 1981), (2) ant mimicry (Lev-Yadun and Inbar, 2002), (3) aphid mimicry (Lev-Yadun and Inbar, 2002), (4) caterpillar mimicry (Rothschild, 1984; Lev-Yadun and Inbar, 2002), (5) animal chewing or tunneling damage mimicry (Smith, 1986; Niemelä and Tuomi, 1987; Soltau et al., 2009), and (6) carrion and dung odors of various flowers, which simultaneously attract pollinators and mimic predator and parasite danger (Lev-Yadun et al., 2009). For recent discussions on the specific factors involved in the potential defensive role of animal mimicry by plants, see Lev-Yadun and Inbar (2002), Lev-Yadun et al. (2009), and Schaefer and Ruxton (2009).

Here, I show that many *Passiflora* species have dark dots and short stripes on their flowers, and suggest that these visually mimic ants, adding to the two previously described types of animal mimicry that may protect *Passiflora* plants from herbivory.

This paper is dedicated to the memory of Professor Joshua Kugler.

### MATERIALS AND METHODS

The predominantly American genus *Passiflora* comprises more than 500 species, some of which commonly attract ants by means of extrafloral nectaries on the bracts or on the back of the sepals (Ulmer and MacDougal, 2004). After finding dark dots and short stripes that appear to the human eye to resemble ants on the anthers and stigmas of many species of *Passiflora* growing in Israel (Fig. 1), I studied the figure plates in Ulmer and MacDougal (2004), which cover several dozen *Passiflora* species, to examine whether this putative ant mimicry is a common phenomenon in this genus.

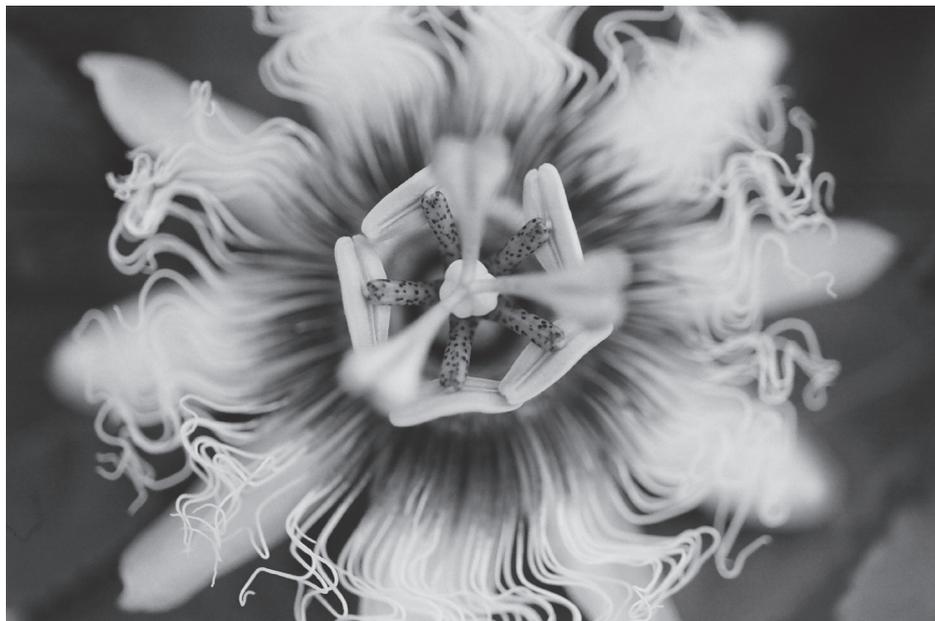


Fig. 1. Visual ant mimicry in the anthers of a *Passiflora* sp. flower growing in Israel.

## RESULTS

The examination of pictures of the dozens of *Passiflora* species documented in Ulmer and MacDougal (2004) suggests that visual ant mimicry exists in at least 22 species. In 17 species (*P. amethystina*, *P. cincinnata*, *P. deltoifolia*, *P. eichleriana*, *P. exura*, *P. foetida*, *P. garckeii*, *P. gibertii*, *P. incarnata*, *P. mayarum*, *P. menispermifolia*, *P. mooreana*, *P. oerstedii*, *P. speciosa*, *P. subrotunda*, *P. tenuifolia*, and *P. trisulca*), the anthers and stigmas were mottled (Fig. 1), and in five other species (*P. candida*, *P. gracilis*, *P. lancearia*, *P. rhamnifolia*, and *P. sclerophylla*), the petals were mottled. It is likely that additional such species exist among the many *Passiflora* species that were not documented.

## DISCUSSION

The American genus *Passiflora* is the best-known plant genus with regard to several morphological adaptations suggested to have evolved to reduce herbivory via animal mimicry. The best-studied case is of butterfly egg mimicry by the leaves of several *Passiflora* species, which has been suggested to reduce egg-laying by *Heliconius* butterflies, but seems to operate also for other plant and butterfly taxa (Benson et al., 1975; Shapiro, 1981; Schaefer and Ruxton, 2009). The second type of defensive animal mimicry in this genus was noted by Rothschild (1984) for the stipules along the branches of *Passiflora caerulea* that resemble caterpillars, slugs, or snails crawling along the stems.

Defensive ant (Formicidae) mimicry in the shape of dark spots and flecks along the stems, branches, and petioles of *Xanthium strumarium* (Asteraceae) and on the petioles and inflorescence stems of *Arisarum vulgare* (Araceae) was suggested by Lev-Yadun and Inbar (2002). However, no experimental work indicating actual herbivore deterrence has been conducted to date.

The potential benefit from ant-attendance mimicry for the plants is clear. Ants as a group are ubiquitous, numerous, and aggressive, thus often deterring herbivores. Many plant species are actually protected from herbivory by attracting "real" ants (e.g., Huxley and Cutler, 1991; Jolivet, 1998), while a variety of arthropods are known to mimic ants as a defense mechanism against predators (e.g., Wickler, 1968; Edmunds, 1974). Moreover, butterflies were found to distinguish predaceous ants on plants by sight and to select enemy-free plants (Sendoya et al., 2009). Thus, plants may benefit from defensive ant mimicry if herbivores consider them to be occupied by real ants and so refrain from occupying and consuming them, especially their reproductive organs (Lev-Yadun and Inbar, 2002).

The hypothesis that visual ant mimicry, in the shape of dark dots and short stripes, occurs in flowers is not exclusive. Such coloration also serves the function of attracting pollinators and leading them to and within the flowers (Dafni and Giurfa, 1999; Biesmeijer et al., 2005). A dual purpose of flower characters for both pollination and defense has been suggested many times for various visual and chemical flower characters (e.g., Hinton, 1973; Strauss and Whittall, 2006; Hansen et al., 2007; Lev-Yadun, 2009).

Ant mimicry is not necessarily the sole option of defensive mimicry by means of the dark spots on flowers of *Passiflora*. Such spots may also mimic aphids. Aphid mimicry has already been suggested to defend plants from herbivory because aphids refrain from colonizing plants already occupied by other aphids (Lev-Yadun and Inbar, 2002, and citations therein).

I conclude that in the flowers of many *Passiflora* species the coloration pattern raises the possibility of a visual defensive ant or aphid mimicry. While the evolution of such coloration patterns in flowers could be attributed primarily or solely to pollinator attraction, the occurrence of such color patterns on stems and leaves seems to be purely defensive. The physiological functions of anthocyanins (the pigments responsible for the suggested ant mimicry patterns), such as defending the plant from photoinhibition and photooxidation (e.g., Lev-Yadun and Gould, 2008, and citations therein), do not explain the dot and stripe patterns. Thus, it is possible that visual ant mimicry by plants is a common phenomenon, the extent of which should be studied globally. When studying the complicated plant–ant relationships, defensive ant mimicry by plants should also be taken into account. The suggested ant mimicry in *Passiflora* adds to the increasing number of cases of apparent defensive plant coloration.

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