SNAPSHOT: Sticky Plants in Your Garden *by Billy Krimmel*[1]

Sticky plants are widespread in summertime throughout California. The oils and resins secreted at the tips of their ***glandular trichomes*** often shine in the hot sun, and in many instances are strongly fragrant (see definitions below). Some scientists have argued that UV reflectance may have been why plants evolved glandular and non-glandular trichomes in the first place—to mitigate the effects of the hot sun drawing out water from the plant's stomata (tiny openings through which plants breathe). Others have argued that plants secrete ***glandular exudates*** as a way to detoxify (Schilmiller et al. 2008), while still others argue that they evolved as a way to repel or defend against would-be insect herbivores (e.g., Duke 1994, Fernandes 1994). Glandular trichomes are found among diverse plant taxa — an estimated 30% of all vascular plant species have them — and likely evolved in response to a diversity of environmental drivers (Duke 1994).

DEFINITIONS

Glandular trichome: Plant epidermal hairs with glands that produce and secrete glandular exudates

Glandular exudate: Substances secreted by glandular trichomes with a wide variety of chemical constituents, performing myriad functions, and including biologically active compounds such as fatty acid derivatives, phenylpropanoids, polyketides, and terpenoids.

Adaptations to sticky plants by insects

Regardless of how these sticky hairs evolved, they carry out a fascinating array of functions. And because they are so abundant, many insects and other arthropods have evolved intricate adaptations that allow them to thrive on the sticky plant surface (Wheeler and Krimmel 2015). By virtue of being sticky, these plants accumulate a diversity of materials on their surface, from dust to pollen to dead insects that became entrapped and unable to escape. The insects that live and feed on sticky plants tend to be widely omnivorous, feeding on these different resources as well as the plant itself and other live insects (Figure 1) (Wheeler and Krimmel 2015).

These insects also tend to be long-legged — in some cases tip-toeing around the surface to carefully avoid getting caught up, and in other cases slogging through with strong leg muscles (Voigt et al. 2007). Plant bugs in the subfamily Dicyphini (Hemiptera: Miridae: Dicyphini) have specialized hooks on their legs that enable them to latch on to trichomes near the tips so they can walk on top of the trichome canopy and avoid contact with sticky droplets at the tips (Voigt et al. 2007). Some of these bugs also possess the ability to secrete grease along the bottom of their abdomens, so that if they do contact sticky exudates by accident, they can slough it off and move on without becoming entrapped (Voigt and Gorb 2008).

Another common visitor of sticky plants is a group of assassin bugs in the subfamily Harpactorini (Reduviidae: Harpactorini). Females in many species have specialized storage structures on their abdomens for collecting and storing sticky exudates from plants. As females in these species lay eggs, they coat the eggs with these exudates. Newly hatched nymphs then spread the exudates from their egg onto their body—the functions of which is still a bit of a mystery. Investigators speculate that it might provide camouflage, better grip to the plant for the insect, anti-microbial functions, better attachment to prey, some combination of these functions, or something completely different (Law and Sedigi 2010). Perhaps a *Grasslands* reader will solve the mystery through observation and experimentation of

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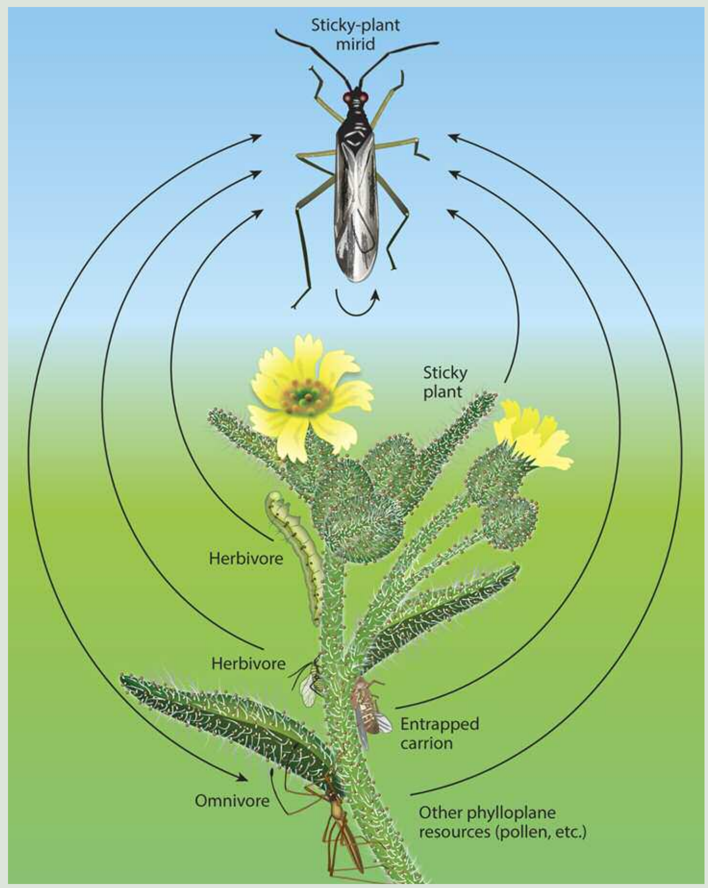

Figure 1. A theoretical food web for a sticky plant. Mirids feed as broad omnivores on sticky plants, consuming resources stuck to the plant surface (e.g., carrion), herbivores, other omnivores, and their host plants. Species in graphic are a simplified representation of the arthropod community on slender tarweed (*Madia gracilis*; Asteraceae) and are meant to depict a "typical" sticky-plant food web rather than formally quantified interactions. *Image courtesy Wheeler & Krimmel 2015*

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Figure 2. The sticky plant surface. *Hoplinus echinatus* and a dicyphine mirid forage for whitefly corpses stuck to *M. elegans* in a garden in Davis, CA. *Photo courtesy the author*

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sticky plants in her garden.

Many of the arthropods living on sticky plants feed on the corpses of entrapped insects attached to the plant surface. Even caterpillars that feed on sticky plants, like the tobacco budworm (*Heliothis virescens),* feed on this carrion, consuming it as they chew on leaves and buds and also seeking it out as they forage (Krimmel and Lopresti, in prep).

Carrion-mediated indirect defense on sticky plants

By entrapping small insects on their sticky hairs, sticky plants provide food for predatory arthropods. This food may be particularly important for young predators that are too small to capture large, mobile prey. As they grow, these predatory arthropods begin hunting live prey, which includes the herbivores of the sticky plants. The end result is enhanced defense against herbivores via increased predator abundance, an interaction called indirect defense.

In a study of common madia (Asteraceae: *Madia elegans*), increased carrion on the plant surface (Figure 2) increases the abundance of a suite of predatory arthropods, including the stilt bugs *Jalysus wickhami* and *Hoplinus echinatus*, the assassin bug *Pselliopus spinicollis*, and two species of spider. This translates into less herbivory by the caterpillar *Heliothodes diminutiva*, which feeds on the buds and flowers of *M. elegans*. Results showed that *M. elegans* plants with more carrion experienced more fruit production (Figure 3) (Krimmel and Pearse 2013).

In the case of serpentine columbine (Ranunculaceae*: Aquilegia eximia*), the plants take this a step further. The sticky substances they produce release odors that lure insects to land on the plant and get stuck, effectively playing a 'siren song' to unsuspecting passers-by (Lopresti et al. 2015).

Good sticky natives for the garden

The trait of stickiness has evolved many different times among many different native plant taxa (Wheeler and Krimmel 2015). Some good examples of sticky native plants suitable (and available) for gardens include common madia, serpentine columbine, seep monkeyflower (Phrymaceae: *Erythranthe guttata*), scarlet monkeyflower (Phrymaceae: *Erythranthe cardinalis*), and coyote tobacco (Solanaceae: *Nicotiana attenuata*).

Species snapshot: Common madia

Common madia is a deep-rooted annual with seeds germinating in the early winter and most plants flowering from summer into fall. In the early morning, the flowers of *M. elegans* are wide open and conspicuous. As the summer days heat up, the flowers shrivel and close and plants become less conspicuous. In the late

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Figure 3. Clockwise from upper left: (1) *Hoplinus echinatus* scavenges on a dead fly on *M. elegans.* (2) *Pselliopus spinicollis* scavenges on a dead fly on *M. elegans*. (3) *Pselliopus spinicollis* feeds on the caterpillar *Heliothodes diminutiva on M. elegans.* (4) *H. diminutiva* feeds on a flower bud on *M. elegans. Images courtesy Krimmel & Pearse 2013*.

summer it is one of few abundant species flowering and growing during a time when many native and non-native plants are dormant or have already set seed and senesced. As such, it is an important habitat plant for many native pollinators and other arthropods. Even ladybeetles, not particularly well-suited for walking around on the sticky surface, visit *M. elegans* in the late summer to feed on aphids, which are otherwise scarce (Krimmel and Pearse 2013). Furthermore, native bees can be seen collecting resins from the glandular trichomes of *M. elegans*, which they presumably use as an additive to soil when constructing partitions for their nests; these resins have been shown to fortify nest partitions in certain species such that parasitic wasps cannot break through (Mathews et al. 2009).

Keep an eye out for dead insects stuck to the sticky hairs of *M. elegans*, and for the long-legged arthropods that are able to move around on and among the hairs. These arthropods include stilt bugs (Hemiptera: Berytidae), dicyphine mirids (Hemiptera: Miridae: Dicyphinae), green lynx spiders (Aranae: Oxyopidae), harpactorine assassin bugs (Hemiptera: Reduviidae: Harpactorinae), aphids and tree crickets (Orthoptera: Oecanthinae). Watching long enough, one can observe many of these arthropods feed on entrapped insects on the plant surface.

Some added bonuses of growing *M. elegans* include its smell — a sweet, citrusy fragrance — and highly nutritious seeds. California ground squirrels (*Otospermophilus beecheyi*) may be seen standing on hind feet to chew off ripened seed heads, their faces encrusted with oils. Gold finches and other seed-feeding birds hop around on *M. elegans* plants, and humans can eat the seeds too. These high-protein seeds were traditionally a staple crop for the Pomo people, and its congener *Madia sativa* was grown briefly in Asia as a seed oil crop.

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