Waxes and Wax Pores of Adult Silverleaf Whiteflies, *Bemesia argentifolia*, and their Dustywing Predator, *Semidalis flinti*

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ABSTRACT

Adult whiteflies and dustywing cover all parts of the body except the eyes with waxy particles. Whiteflies produce filaments of a waxy material from abdominal wax plates, composed of many pores and use their tibia to periodically break off the extruding filaments to form waxy particles. The particles are a mixture of long-chain aldehydes and alcohols. In Bemesia argentifolia, the major components are 34 carbons in length and in Triaeuroides vaporariorum, 32 carbons. Dustywings have individual wax pores located around the entire body that produces two waxy ribbons with fluted edges. Each ribbon curls back on itself to form cylinders (particles) approximately one millimetre in diameter. The particles consist largely of a 24-carbon fatty acid, tetracosanoic acid, some methyl branched carbohydrates, other fatty acids and fatty alcohols. Thin layer chromotography (TLC) of surface lipids showed fatty acid (77%) alcohols (8%), hydrocarbons (7%), and putative wax esters (3.6%) and diacylglycerols (3.3%). No differences in TLC lipid classes were found between males and females. No putative wax esters were detected in particles alone or by gas chromatography-mass spectrometry. The major hydrocarbon was 3,7,11-trimethylheptacosane.

Whiteflies (Homoptera: Aleyrodidae) are serious pests of many plants world-wide. They stunt the plant and reduce production by sucking plant sap and excreting honeydew. The honeydew covers the leaves, traps waxy particles produced by the adults and promotes the growth of mould on the leaves, reducing the photosynthetic capabilities of the plants. They are also vectors of plant viruses. Whitefly species in the genus Bemisia, i.e., *B. tabaci* Gennadius and *B. argentifolii* Bellows and Perring, are particularly important pests on cotton, melons, tomato, broccoli, cauliflower and other vegetables. On cotton, honeydew from whiteflies not only covers the leaves, but falls onto the lint in open bolls, making it sticky, and creating problems during ginning and spinning.

A number of predators and parasitoids contribute to the natural control of *Bemisia* (Gerling, 1990). The dustywing, *Semidalis flinti* Meinander (Neuroptera: Coniopterygidae), a less-studied predator in the south-western USA, appears to be closely associated with whiteflies. It is particularly active on non-crop plants (shrubs and trees) in areas surrounding agricultural and urban lands where whiteflies occur between crop seasons. Both larvae and adults are voracious feeders on whitefly eggs and nymphs. In laboratory studies, dustywing larvae consumed up to 2000 whitefly eggs during their development to adults (Hoelmer *et al.*, 1998). In one hour, individual starved adults ate an average of 8.5 eggs plus 8.8 nymphs.

Somewhat unique to adult whiteflies and their dustywing predator is that both cover themselves with waxy particles that coat all parts of the body except the eyes. Adult whiteflies and dustywings cover their cuticular surface with lipid that is largely composed of long-chain wax esters. Many other species of insect cover their cuticular surface with lipid that is largely hydrocarbons. Whiteflies produce ribbons of a waxy material from abdominal wax plates, composed of many pores, and use their tibia to periodically break the extruding ribbons to form the waxy particles. The particles are a mixture of long-chain aldehydes and alcohols. In *B. argentifolii,* the major components are 34 carbons in length and in greenhouse whiteflies, Trialeurodes vaporariorum, 32 carbons.

Dustywings were collected from nearby roses In the summer and fall of 1996 and 1997, the USDA-ARS laboratory in Phoenix, AZ, cultured *B. argentifolii* on cotton leaves and sent them to the USDA-ARS laboratory in Fargo, North Dakota for analysis. Dustywings do not have wax plates as do whiteflies. Dustywings have individual wax pores, located around their entire body, that produce two waxy ribbons with fluted edges. Each waxy ribbon curls back on itself to

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form a cylinder (particle) approximately one micrometer in diameter. As the waxy ribbon continues to be extruded, the end of the ribbon continues to curl back on itself and additional particles are formed. In a manner similar to whiteflies, dustywing adults use their tibia to transfer the waxy particles from the pores to cover their body. This is done soon after eclosion. As the particles are lost to the substrate, periodic re-waxing is necessary.

Surface waxes are difficult to examine by electron microscope as routine fixation and dehydration procedures remove or alter their surface characteristics. Fully hydrated whiteflies and dustywings were frozen fresh and then sputter coated with gold/palladium. They were then examined and photographed, using a JEOL JSM6300 scanning electron microscope operated at low accelerating voltages.

Cuticular surface lipids and waxy particles were extracted from dustywing adults with chloroform. Waxy particles coating glass vials in which the adults were shipped were extracted with chloroform. The lipids were first analysed by thin-layer chromatography (TLC) on silica gel plates developed in hexane:diethyl ether :formic acid (80:20:1). The lipid classes were visualised and quantified after charring the plate by spraying with 5% sulphuric acid in 95% ethanol and heating. The area and density of the charred areas was determined after scanning into a computer. The total cuticular surface lipids were composed of fatty acids (47%), alcohols (7%), hydrocarbons (20%), putative wax esters (4%) and diacylglycerols (10%). Eleven percent of the lipid extract remained at the origin of the TLC plate.

The lipid classes of the waxy particles coating the glass vials were also determined by TLC. The waxy particles were composed of fatty acids (37%), alcohols (9%), hydrocarbons (19%), and diacylglycerols (13%). Twenty percent of the extract from the glass vials remained at the origin of the TLC plate. No differences in TLC lipid classes were found between males and females. No putative wax esters were detected in particles alone. The similarity in the lipid composition of the waxy particles and the total cuticular surface lipids indicated that the waxy particles make up the majority of the lipid on the surface of the insect.

Following TLC analysis, the chloroform extracts were analyzed by capillary gas chromatography-mass spectrometry. Again, no wax esters were detected. The major hydrocarbon was 3,7,11-trimethylheptacosane, approximately 70 ng per female. Females had about twice as much as did the males. The free fatty acids and alcohols were determined by CGC-MS after converting them to their trimethylsilyl derivatives. The major lipid class was the free fatty acids. The major free fatty acid from both the insects and the particles in the vials was a 24-carbon fatty acid, tetracosanoic acid, about 50% of the total fatty acids. There were about 1000 ng of fatty acids per insect. Alcohols were only a minor lipid class on dustywings. The major alcohol was a mixture of 8- and 9-hydroxypentacosanols.

The most obvious differences in surface chemistry between whiteflies and dustywings was absence of free fatty acids on adult whiteflies and absence of have long chain aldehydes on adult dustywings. In addition, dustywings had a significant amount of branched hydrocarbons while whiteflies had very little branched or straight chain hydrocarbon. The purpose of the waxy coating is not known. Suggested possibilities for the coating in whiteflies, and other insects include 1) preventing water loss, 2) waterproofing against water droplets, and 3) protection from sticking to honeydew (Byrne and Hadley, 1988).

References

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