

Potential new citrus pest: Japanese bayberry whitefly

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A newcomer to California from Japan, this pest is spreading. Two predators have been successfully introduced, search for another is under way in China.

Japanese bayberry whitefly, *Parabemisia myricae* (Kuwana) was first detected in southern California in October 1978 during cooperative state and federal inspections for the citrus blackfly, *Aleurocanthus woglumi* Ashby. Ray Gill, California State Department of Food and Agriculture (CSDFA), identified the newly discovered whitefly species. By December 1978, seven counties (Fresno, Kern, Los Angeles, Orange, San Bernardino, San Diego, and Santa Barbara) were known to harbor infestations in nurseries or (in Los Angeles and Orange counties) on residential properties.

Japanese bayberry whitefly is apparently native to Japan and possibly to other parts of Asia as well. It thus is an international invader of California, as were citrus whitefly, *Dialeurodes citri* Ashmead, and woolly whitefly, *Aleurothrixus floccosus* Maskell.

We were asked by the CSDFA to undertake biological control studies of *P. myricae* beginning in June 1979. Our 1979 detection surveys showed that field populations of the whitefly were centered in the San Gabriel-San Marino areas of Los Angeles County and in the Tustin-Santa Ana areas of Orange County. At first, we found no evidence of this whitefly in commercial citrus, but by October 1979, infestations appeared on lemons at the South Coast Field Station in Irvine.

During June and July 1979, all field populations observed were small, but by late August they had increased several hundred-fold on the same locations. These dense whitefly populations caused defoliation of infested leaves when dry winds began in the fall. Overwintering populations therefore were greatly reduced from the highest densities reached.

Even so, by June 1980, infestations in a large block of commercial lemons on the Irvine Ranch in Orange County became so dense that emergency high-volume oil and Rotenone treatments were applied. In the absence of effective natural enemies, the whitefly demonstrated potential as a serious citrus pest capable of causing severe damage.

Interestingly, adults and early larval stages (instars) of the whitefly were also found on nearby new plantings of Hass avocados on the Irvine Ranch. The whitefly has also recently invaded Israel, where it is generally attacking avocados. We are now evaluating avocado as a possible host plant.

The whitefly

The adults are smaller than either citrus or woolly whitefly and have a dusty blue-gray or lavender appearance. The adult female lays eggs selectively on new, small foliage often referred to as "feather growth" or "shoots." Eggs, each attached with a supporting pedicel, are laid on both sides of the preferred leaves as the adult feeds. The eggs darken within a day or so and are conspicuous to the naked eye, especially on the edges of leaves.

The mobile crawler stage of the first instar usually migrates to the underside of the leaf to settle and feed with its sucking mouth parts, but some remain on the upper leaf surface. Larval stages have a clear wax fringe or "skirt" around the body margin, which is most easily seen on the fourth instar. Adults also feed and lay eggs on fruit and green angular wood. Complete larval development occurs on the green wood.

Japanese bayberry whitefly larvae produce large amounts of honeydew, although not as copiously as woolly whitefly. In initial comparative tests with Argentine ants, *Iridomyrmex humilis* Mayr, in a glasshouse and in the field, the ants were not seen feeding on honeydew of *P. myricae*, but more recently some foraging of the honeydew by the ants has been observed.

As the honeydew is secreted, it falls onto the upper surfaces of leaves below those infested by whitefly. The honeydew supports the growth of sooty mold, *Cladosporium* sp., and collects airborne residues and dust, which blacken leaves and interfere with photosynthesis. Large infestations can blacken nearly entire trees and cause defoliation.

Male whitefly were extremely rare (5 males to 1,200 females in a check during August-

September 1979, which suggested parthenogenetic reproduction (deuterotoky). Later glasshouse culturing confirmed this to be true. We also found that the entire life cycle of the whitefly, egg to adult, required as few as 21 days under variable day/night conditions of 21.1 ° to 17.3 ° C and 65 to 100 percent relative humidity in glasshouse culture. This short life cycle coupled with parthenogenetic reproduction and an as yet unknown, but apparently high, reproductive capacity explained the rapid increases we observed in field populations.

Parthenogenetic reproduction enhances successful dispersal by winged female whitefly. Explosive population increases and rapid dispersal caused the known infested area in southern California to become much larger during 1980, extending from the Pasadena-San Gabriel-San Marino areas in the north to Pico Rivera and Whittier in the west in Los Angeles County and as far south as Rancho Santa Fe in San Diego County. Inland, in Riverside County, Corona is also widely infested. Commercial citrus within this range in Los Angeles, Orange, Riverside, and San Diego counties is now generally infested.

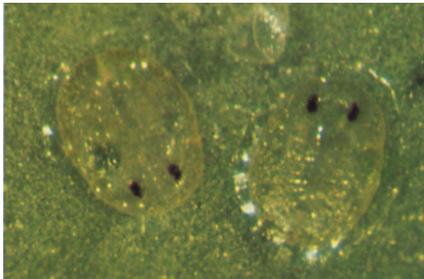
Biological control

No evidence has been found of satisfactory extrinsic regulatory agents of this whitefly in California. General predators, such as coccinellids, coniopterygids, chrysopids, and syrphids, have all been observed feeding on high-density whitefly populations, but without apparent impact. Hymenopterous parasites, *Encarsia* spp., of other whitefly species do parasitize the bayberry whitefly and have been recovered in the above four counties. These probable native parasites generally exist in low numbers (less than 1 percent parasitization) without apparent ability to increase rapidly relative to increased whitefly densities, and thus seem incapable of regulating Japanese bayberry whitefly alone.

The lack of effective natural enemies in California is characteristic of invading pest insects when they reach new, geographically



Above: Adult Japanese bayberry whitefly with small, white, newly deposited eggs on young lemon about 3 cm in diameter.
 Left: Adults and newly laid eggs on young lemon shoots.
 Below left: Fourth-stage larvae with eye spots and wax fringe.
 Below right: Adult on leaf with eggs of various ages.



distant habitats. Other examples of such invaders of citrus in California are the California red scale, *Aonidiella aurantii* (Mask.); cottony-cushion scale, *Icerya purchasi* Mask.; purple scale, *Lepidosaphes beckii* (Newman) and, as previously mentioned, *A. floccosus* and *D. citri*.

From the literature we knew that a parasite of Japanese bayberry whitefly—*Encarsia* (= *Prospaltella*) *bemisiae* (Ishii)—had previously been discovered in Japan and that the whitefly was there known from three primary locations. After beginning searches in Japan in September 1979, we soon discovered parasites in Kochi, on the island of Shikoku, where biological control of the whitefly is excellent. Following intense field collection, specimens of *P. myricae* containing immature parasites were hand-carried back to the Quarantine Insectary at the Experiment Station in Riverside.

From these collections three parasite species, all apparently new, were reared. Glasshouse cultures were successfully initi-

ated, and field colonizations were made in Los Angeles and Orange counties. Two of these newly imported parasites, *Encarsia* sp. and *Eretmocerus* sp., are continuing to reproduce in the field, although, as yet, in low numbers. The third parasite species, which belongs to a different taxonomic group, will be discussed in a later publication.

None of the parasite species introduced in 1979 met the descriptive criteria of *E. bemisiae*. We therefore returned to Japan in 1980 to further explore and collect, so that all possible parasite species of *P. myricae* living there would be introduced to California. Parasitized whitefly were collected and shipped from Japan during July-August 1980, but no *E. bemisiae* were recovered. Additional field colonizations of *Encarsia* sp. resulted from these 1980 importations, and initial evidence of reproduction in the field following colonization has been observed.

We do not yet know if the recently introduced parasites, *Encarsia* sp. and *Eretmocerus* sp., will regulate *P. myricae* popula-

tions in southern California; only time will tell. Additional importation of parasites from the indigenous range of the whitefly will ensure that the most suitable natural enemy or complex of natural enemies will become established throughout the whitefly-infested areas in California. Because the whitefly may eventually infest more climatically diverse areas, such as the inland valleys, we expect that different natural enemy complexes may also be required to attain satisfactory biological control throughout its ultimate range. To this end, foreign exploration for parasites of the whitefly has been undertaken in China.

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Japanese bayberry whitefly, continued



Left: Honeydew has fallen on citrus leaf below leaf infested by whitefly larvae.
Bottom left: Underside of lemon leaf is covered with pale yellow pupae, pale white pupal cases, and newly emerged Japanese bayberry whitefly adults.
Below: Sooty mold growing on honeydew that has fallen on upper surface of lemon leaves.

