

## Scale Pests of Florida Citrus <sup>1</sup>

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### Introduction to Scales

#### Armored Scales

Armored scales are in the family Diaspididae, which contains a number of very important pest species. The females of this family insert their long mouthparts as crawlers and never move again. The immature male also becomes immobile until emerging as an adult. Females and immature males are covered by protective coatings called the armor. This armor is constructed primarily of wax secreted by the insect and also includes the cast skins (exuviae) of earlier instars. Depending upon the species, the female lays eggs or live young under this protective coating of armor. Armored scale can be differentiated from a soft scale in the field by lifting the armor covering. The armored scale can then be lifted free of its armor, while the soft scale insect cannot. In some cases, a membranous sheath is secreted under the armored scale. When determining the population of armored scales in the grove, it is important to remember that the armor of dead scales will stay on the tree for some time and confuse the living scale count. A crude method for determining if the scale is alive is to squeeze the armor or body. If juice is exuded, the scale is probably alive.

There are several armored scales which are important pests of Florida citrus. These include black parlatoria scale, citrus snow scale, Florida red scale, and purple scale.

#### Soft Scales

Soft scales differ from armored scales in several ways. Unlike the protective covering of the armored scale, no true armor is formed by soft scale. Instead, the skin or body wall is hardened by a wax-like secretion which is either incorporated into the skin itself or formed into a layer on top of the skin. The soft scale insect cannot be lifted free of its shell. The female is not fastened permanently to the tree bark, but is able to move about until the eggs begin to form. The mouthparts are not as long as those of the armored scale and the soft scale is able to withdraw and insert them at will. As the eggs form, the legs are covered and rendered useless by the swelling of the body. Eggs are laid under the female or retained in the body until hatched. The soft scale gives off large amounts of honeydew upon which the sooty mold fungus thrives. This fungus forms a black covering on the leaf which prevents photosynthesis. The soft scale seldom injures mature trees, but can be harmful to nursery stock. After dying the soft scale easily falls

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off the tree instead of remaining as the armored scale does.

The two major soft scale pests of citrus covered here include Caribbean black scale and cottony cushion scale.

## General Physical Description and Life History

Scales belong to a highly specialized group whose members look very little like other insects. The scale feeds upon plant juices, which it sucks through its embedded mouthparts.

The female adult scale is wingless and often has no legs. The adult male usually has one pair of wings and well developed legs. The male looks somewhat like a tiny gnat, but is not usually seen. The adult male lacks mouth parts and does not feed. The adult male may live for only a few hours while adult females of some species live for months.

Both sexes begin life as crawlers which have either hatched or where born alive. These crawlers may travel some distance to a new plant. Eventually they settle down and insert their piercing-sucking mouthparts into their hosts.

### Overall Economic Importance

Scales injure crops by feeding upon plant juices through embedded mouthparts. When a scale infestation is severe, it may drastically affect plant vigor and even kill the plant. Typical symptoms of infestation are moderate to severe defoliation and fruit drop.

### General Economic Threshold

Large numbers of crawlers do not always indicate an infestation since the mortality rate of the first few instars is extremely high. For most of the scale species present on citrus, biological control of the later instars and adults is also quite effective. Problems usually arise due to improper spray programs. Over spraying, or use of pesticides not recommended, can seriously weaken the biological control complex holding most scale populations in check. An insufficient spray program can also result

in large scale populations. For example, snow scale is difficult to control with highly concentrated sprays.

## Individual Scales

### Black Parlatoria Scale

#### Introduction

Black parlatoria scale, *Parlatoria ziziphi* (Lucas), or Ebony scale is one of five Parlatoria species known to attack citrus, and in many areas of the world it is considered a major pest of citrus. The presence of this scale on citrus in the United States was confirmed in October, 1985 when it was found in several locations in northeast Miami, FL. In January of 1986, additional infestations were discovered. This was the first established infestation of this scale in the continental United States. This scale is established on other tropical and sub-tropical areas of the world, including the Caribbean. This scale feeds almost exclusively on citrus and is rarely recorded on other hosts. The armor of this species sticks so strongly to the substrate that it is practically impossible to remove. Masses of this scale may occur on leaves and fruit.

#### Physical Description and Life History

The armor of the female black parlatoria scale appears to be flat to slightly convex. It is conspicuously black, shield-shaped and about 1.25 to 2.00 mm long. The first exuviae is a small black oval. The second exuviae is slightly convex and is rectangular with rounded angles. There is usually a fringe of white around the posterior perimeter of the armor. The armor of the male is flat, elongate, white, and about 1/3 the size of the female. The male exuviae is black to brown in color.

All stages of development of the black parlatoria scale can be found throughout the year. The adult female lays from eight to 20 eggs. Depending upon the region of the world reported from, there are from three to seven generations per year and each generation may take from 30 to 93 days to develop. In colder weather the time required is much longer. Leaves are the preferred feeding site, but fruit and branches are also attacked. The scale is found on both surfaces of the leaf. This species is somewhat



**Figure 1.** Black Parlatoria scale infestation. Photograph by: Charles Olsen, USDA APHIS PPQ, United States

unusual in that it is so tightly attached to the host that it is nearly impossible to remove without destroying the substrate and the scale.

### Economic Importance

The black parlatoria scale has long been considered one of the major pests of citrus in certain areas. In some countries the scale may not be considered a serious pest, but populations occasionally become a problem in localized areas. Heavy infestations of this scale cause chlorosis and premature drop of leaves, dieback of twigs and branches, stunting and distortion of fruit, and fruit drop before it is mature. Perhaps the most characteristic damage is the virtually unremovable scale cover on the fruit. Generally, the scale is so firmly attached to the fruit that it cannot be removed, causing rejection in most fresh fruit markets.

## Caribbean Black Scale

### Introduction

Three species of black scales are found in Florida. Caribbean black scale, *Saissetia neglecta* (De Lotto), is the principal species which infests Florida citrus. Mexican black scale, *S. miranda* (Cockerell & Parrott), which also attacks citrus is seldom found in Florida. Black scale, *S. oleae* (Olivier), often called olive scale, is primarily a pest of olive trees and oleander.

### Physical Description and Life History

The full grown female Caribbean black scale is 3 to 5 mm long and brown to black in color. It has a very tough shell which is nearly circular or hemispherical. Two lateral ridges and one long longitudinal ridge create an "H" shaped pattern which helps identify this genus. As adults, the males are usually very scarce. They have two wings, are about 1 mm long and are honey-yellow.



**Figure 2.** Adult female scale. Photograph by: Lyle J. Buss, UF/IFAS

Young scales are oval, flattened, and a mottled brown. In this stage, young black scale are very similar to young soft brown scale. However, the older stages of black scale are easily recognized by the hemispherical shape, dark color and the raised "H" pattern. The second instar is similar to the first except that it is larger. It is during the second instar that the "H" pattern begins to form. After the second molt, the female scale is tan to dark grey in color. This is called the "rubber stage" and denotes the period when ordinary pest control methods are no longer effective. During this period the scale migrate from the leaves to small twigs, particularly to those twigs bearing fruit. As the female reaches the egg-laying stages, its shell becomes hardened and dark brown to black in color.

The crawlers are small, about 0.34 mm long and are light brown with black eyes. They travel about considerably before settling. A large percentage of the crawlers fail to settle on the tree and those that do may suffer appreciable mortality during periods of hot, dry weather.

The female lays an average of 2,000 eggs and reproduction is usually by parthenogenesis (no fertilization by the male). The eggs are oval and pearly white in color. They later change from white to cream to reddish orange before hatching. Incubation takes from two to six weeks, depending on the weather. Florida has up to four generations of Caribbean black scale a year.

## Citrus Snow Scale

### Introduction

Citrus snow scale, *Unaspis citri* (Comstock), has been known to infest citrus since 1880 when Comstock separated it from the euonymus scale. Citrus snow scale did not become an important pest until the increased development of new groves in the early 1960s. This, combined with the replacement of trees killed by the 1962 freeze, brought thousands of young trees from infested nurseries and spread citrus snow scale throughout the state. Citrus snow scale crawlers are present most of the year due to overlapping generations. As crews move throughout the groves and into other groves, the crawlers move onto the clothing and equipment and are carried to new locations, producing new infestations. Citrus snow scale is believed to be host specific to citrus. However, mandarins seem to lack the heavier infestations which occur on other varieties, and Dancy tangerines may be immune to citrus snow scale attack.

### Physical Description and Life History

There is no well-defined succession of generations of citrus snow scale in Florida. All stages of development are present most of the year.

The adult female is 1.5 to 2.25 mm long. Her armor is oyster-shell shaped with a central longitudinal ridge and is brownish-purple to black with a grey border. The adult female is approximately the same size as a female purple scale and is much the same shape except that the posterior portion of the armor is broader than that of the purple scale. It is inconspicuous and difficult to detect against tree bark. It is the snow white color of the male armor that gives the citrus snow scale its descriptive name. The adult male is winged and light yellow and capable of

fertilizing many females. Other species having similar males that are often confused with citrus snow scale include the lesser snow scale which is usually found on twigs and leaves of citrus nursery stock, and the fern scale which is usually confined to the leaves. The females of these species are readily distinguished from citrus snow scale females.



**Figure 3.** Males and females. Photograph by: J. L. Castner, UF/IFAS

The crawlers are oblong and light orange to reddish in color. They are very small and difficult to see without a hand lens. The female crawler has two immature stages before becoming mature, while the male has three immature stages before developing into its free flying form. Under the protective coating of armor the body of the female is pale yellow while that of the male is bright orange. The immature male has parallel sides and three longitudinal sections, one central with two marginal ridges.

The female lays each egg separately, and another egg is not laid until the previous one hatches. In cool weather, immature scale will remain under the female's armor.

### Economic Importance

Citrus snow scale primarily attacks the trunk and large limbs of the tree. Leaves and fruit are infested usually only after the main branches have developed large overlapping populations. Early symptoms of infestation besides the snowy appearance of the woody tree portions are declining tree vigor and reduced fruit production. Continued infestations result in partial defoliation, dying limbs and branches,

large cracks in the bark, and the eventual death of the tree.

### Cottony Cushion Scale

#### Physical Description and Life History

The early instars of the cottony cushion scale, *Icerya purchasi* (Maskell), are bright red in color with reddish-brown antennae and thin black legs. By the third instar, the scale is broadly oval and reddish-brown, but is largely obscured by a cottony, waxy secretion. The adult female scale is oval and convex, but its characteristic feature is a long white egg sac which has a cottony appearance. The egg sac is usually twice as long as the scale itself, giving the scale an overall length of 10 to 15 mm. The adult male scale is uncommon, small, and has well developed wings.



**Figure 4.** Several life stages of the cottony cushion scales, *Icerya purchasi* Maskell, on a twig. Photograph by: Paul M. Choate, University of Florida

The adult female cottony cushion scale is capable of self-fertilization and lays about 500 to 800 eggs. Eggs are laid within an egg sac and are red and oblong. The eggs can hatch within a few days during the summer months but can take up to two months during the winter. The cottony cushion scale population increases most rapidly during the drier months and requires about four months for a generation. Fortunately, there is a heavy natural mortality among the eggs and the first instar nymphs.

Detailed information of the cottony cushion scale is available on the Featured Creatures WWW site at <http://entomology.ifas.ufl.edu/creatures>.

### Economic Importance

The cottony cushion scale can severely damage trees, resets, and nursery stock. Decreased tree vitality, fruit drop, and defoliation result from the feeding of this scale. Most damage occurs from the feeding of the early immature stages of the scale on the leaves, where they settle in rows along the midribs and veins, and on the smaller twigs. The older nymphs continue to feed but migrate to the larger twigs, and finally, as adults, they settle on the larger branches and trunk. This scale is seldom found on the fruit.

### Florida Red Scale

#### Introduction

Prior to 1962, Florida red scale, *Chrysomphalus aonidum* (Linnaeus), was one of our most serious citrus pests. It was introduced into Florida from Cuba in 1874 and remained a serious concern of growers until a hymenopterous wasp parasite, *Aphytis holoxanthus*, was introduced in 1960. This parasitic wasp quickly reduced Florida red scale to the status of an infrequent pest that usually only occurs following the misuse of chemical pesticides. More than 630 plants have been identified as hosts of Florida red scale. These include avocados, bananas, eucalyptus, guavas, mangos and various palms. However, citrus is the principal host plant. English ivy, used as a foundation plant around homes, serves as a reservoir for both the scale and *A. holoxanthus*.

#### Physical Description and Life History

The Florida red scale adult female has circular armor made up of three rings. It is dark reddish brown with a conspicuous light-brown center which has a nipple-like appearance. The female is about 2 to 2.2 mm in diameter. She must be fertilized before laying eggs. Like other scale insects, the Florida red scale adult male is small, gnat-like and free flying. During the summer, the life cycle of the Florida red scale can be completed in less than six weeks while lower temperatures produce longer life cycles. Florida has six generations a year, with the largest scale population increase occurring in June.



**Figure 5.** Photograph by: Lyle J. Buss, UF/IFAS

The crawlers are bright lemon-yellow and oval. Very active, they move quite a distance before settling down. The female goes through two molts before reaching maturity while the male molts twice and then undergoes a pre-pupal and pupal stage before emerging as an adult.

The Florida red scale female lays an average of 145 eggs which usually hatch in 24 to 28 hours. There are seldom more than five to 10 eggs under her armor at any one time.

### Economic Importance

Florida red scale attacks only the leaves and fruit. On the leaves it generally produces chlorotic spots. These yellow spots also appear at the feeding sites on the fruit. The presence of scale makes fruit unattractive and often reduces its grade. The scales appear to prefer fruit to leaves in the late summer and fall, and the fruit may be heavily infested while adjacent leaves are relatively free of any infestation. Heavy infestations result in severe defoliation and decreased fruit production. Heavy infestations generally occur only when improper use of pesticides has severely reduced or eliminated the parasite population.

## Purple Scale

### Introduction

Purple scale, *Lepidosaphes beckii* (Newman), was the most abundant and injurious insect on Florida citrus prior to 1960. Citrus is its principal host. It infests the leaves, fruit and bark, preferring shady or protected areas such as under leaf surfaces, especially along the midrib. Sooty mold provides an excellent shelter for an infestation of this scale and the presence of large numbers can kill wood and leaves.

### Physical Description and Life History

The armor of the adult female purple scale is 2 to 3 mm long, purple to dark brown in color, elongated, and usually curved in the shape of a comma. The armor of the male is much shorter and more slender, although similar in color to the female. Females undergo two molts before reaching maturity, while the male passes through four stages before emerging as a winged adult.



**Figure 6.** Photograph by: Lyle J. Buss, UF/IFAS

The crawlers are very small, less than 0.25 mm and are pearly white in color. Purple scales lay eggs in masses which fill the armor of the female who then dies. The female lays 40 to 80 eggs which hatch in 15 to 20 days during the summer months. Longer periods are required during cooler temperatures. As the eggs are deposited, the body of the female shrinks until it occupies only a very small area under the armor, then she dies. In Florida, three or more generations may develop each year. Population levels are highest during May. Purple scale is quite similar to Glover scale which is more elongated and slender. The

purple scale lays eggs in a mass which fills the armor, while the female Glover scale lays her eggs in two rows.

### **Economic Importance**

Purple scales feeding on leaves produce yellow, chlorotic spots often resulting in defoliation. Severe infestations can kill trees. Several scales around the stem may cause fruit drop. Fruit quality is also affected since purple scale produces green spots which cannot be removed in the degreening room. Purple scale prefers a dense canopy. Infestations are usually heaviest at the center of the tree and on the north or northeast quadrants. This complicates control since thorough coverage is difficult to achieve in the center of a dense canopy.

### **Control Recommendations**

Scale crawlers can spread infestations rapidly. Although very small, they are highly mobile and can cover impressive distances. Some crawlers are transported on the legs of birds and man, or on clothes and grove equipment. They are also introduced by planting infested resets. One way to avoid introducing scales to a grove is by using only certified nursery stock.

Most scale pests in Florida are under effective biological control. Purple scale and Florida red scale are two good examples. Other species such as citrus snow scale are not yet fully controlled by biological methods alone. Looking for and estimating the percent of scale population exhibiting parasite emergence holes gives a good indication of how effective biological control is in that specific scale populations.

It is possible for biological, or natural, control to be disrupted by the misuse of pesticides which can adversely affect natural controls and produce a resurgence of scale pests. For example, two or more applications of sulfur within a few months can severely reduce the parasite population. Wettable powders of copper, zinc and manganese and even excessive dust, can inhibit the searching ability of parasites and predators. Copper applications also inhibit scale-attacking parasites.

Treatment for black scale must be timed to control the first generation crawlers (between postbloom and summer sprays). Applications at other times are ineffective.

Commercial growers should consult the latest copy of the Florida Citrus Pest Management Guide for recommended insecticides.

### **Black Parlatoria Scale**

Although a number of parasites and predators have been recorded for the black parlatoria scale, the impact of these natural enemies has not been extensively studied. While some of the parasites have been shown to cause up to 40% parasitism, it is unlikely that they will be effective biological control agents by themselves.

### **Caribbean Black Scale**

Caribbean black scale infestations are difficult to control since the scalcicide spray must be timed to coincide with the scale's early stages. Scalcicide sprays applied post-bloom or in summer are not highly effective against black scale because the most easily killed stages appear in mid-May. This period usually falls between the spring and summer sprays. Another generation of black scale appears in mid-July, and a third in November. It is the mid-May crawlers which cause the year's heaviest adult populations during June and July. The most effective natural control of Caribbean soft scale is a hymenopterous (wasp) egg predator, *Scutellista cyanea*. *S. cyanea* inserts its egg under the shell of the female black scale. When the wasp larvae emerges it begins to feed upon the black scale eggs. The incidence of *S. cyanea* increases in mid-June with its highest rate from August through December. This predator does a very effective job of maintaining black scale below economic levels. An entomogenous fungus also grows on black scale eggs. This fungus increases in summer due to heavy rainfall and the population peaks in September.

### **Citrus Snow Scale**

Reports of failure to control citrus snow scale with scalcicides can almost always be attributed to inadequate spray coverage. The denser foliage

brought about by improvements in tree nutrition and pest control have made it more difficult to achieve thorough coverage of the interior of the tree. This problem is further compounded by the use of low-volume or concentrate spray programs. Dilute or high volume sprays have been found to be superior to low volume sprays because they more thoroughly wet citrus snow scale on the trunk and main branches. Another factor adding to coverage difficulties is the nature of citrus snow scale to layer seven to eight individuals deep, preventing penetration by small, low volume spray droplets. In essence, they provide what amounts to their own raincoat. As a result, the recommended interval necessary for the outer layers of citrus snow scale to slough-off is six to eight weeks before applying a second scalicide. Petroleum oil sprays, regardless of strength, are not effective against citrus snow scale. The use of dicofol as a miticide produces an increase in female citrus snow scales. Therefore, if dicofol is applied for mite control, a scalicide should be added to the tank mix.

If the hymenopterous parasite, *Aphytis linganensis*, is established within the grove, the addition of ascalicide usually is not needed. Unlike other scale insect pests, citrus snow scale has very few natural enemies. However, *A. linganensis* has shown great potential in controlling citrus snow scale. Therefore materials lethal or disruptive to the parasite activity, such as sulfur, should not be used.

### **Cottony Cushion Scale**

A predatory beetle and a parasitic fly provide excellent biological control of the cottony cushion scale. The vedalia beetle, *Rodolia cardinalis* (Mulsant), is a very efficient predator due to its excellent searching ability. This ladybird beetle is nearly hemispherical in shape, approximately 3 mm long, and irregularly marked with black and red coloring. The vedalia beetle lays its eggs in the sac of the cottony cushion scale. Both the larva and adult beetle feed on all stages of the cottony cushion scale. A generation of the vedalia beetle requires only one month, which further explains the excellent control of the cottony cushion scale that requires four months for a generation. The vedalia beetle never entirely eliminates the cottony cushion scale, but keeps the population under control. Sometimes the cottony

cushion scale population may recover, but the vedalia beetle soon brings it back to a subeconomic level. The fly, *Cryptochetum iceryae* (Will), is a parasite that lays its eggs in the mature larvae and pupae of the cottony cushion scale. While not as noticeable as the vedalia beetle, this fly also significantly contributes to reductions in scale populations. The vedalia beetle will not feed on scale that has been parasitized by this fly. Chemical control of the cottony cushion scale is rarely needed except in nurseries and young groves.

### **Florida Red Scale**

Florida red scale is parasitized by a wide range of hymenopterous parasites, with *A. holoxanthus* being the most effective. Several species of ladybird beetles also have been reported to feed on Florida red scale. Heavy infestations of Florida red scale generally occur only when the improper use of pesticides has severely reduced or eliminated the parasite population.

### **Purple Scale**

Purple Scale has been under excellent biological control since 1960 due to a parasitic wasp, *Aphytis lepidosaphes*, discovered in 1958 near Ft. Pierce. This wasp attacks the mature female. In addition, about 20 other different kinds of arachnids and insects prey upon purple scale. Chemical control of purple scale is complicated by its preference for a dense canopy. Thorough spray coverage is important, but difficult to achieve in the center of the tree because of dense foliage.