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BOISDUVAL SCALE ON ORCHIDS

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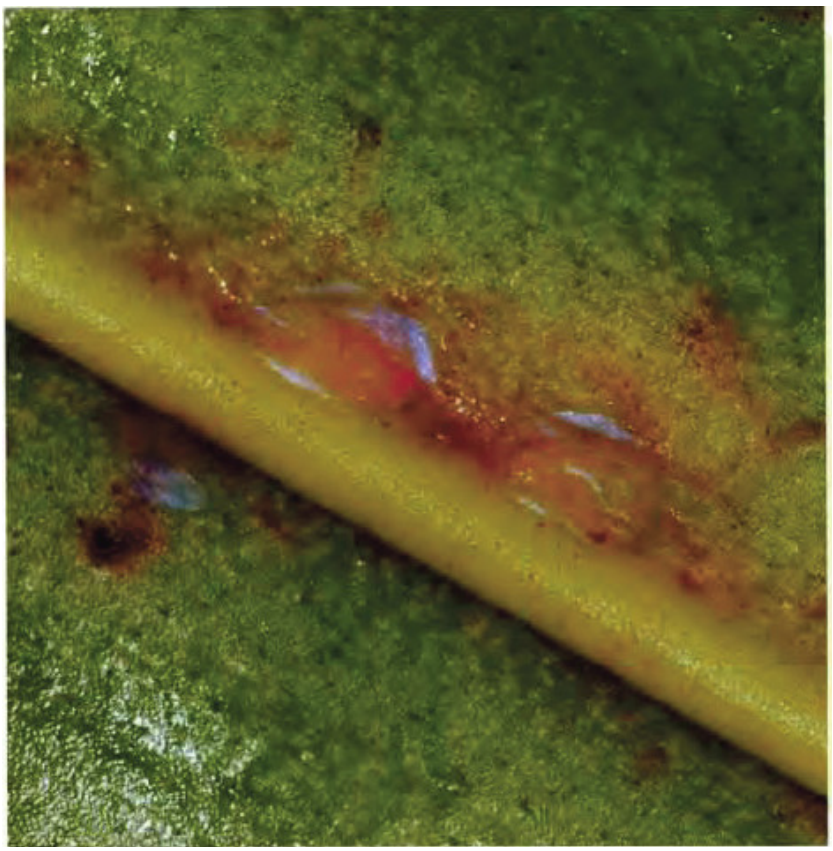
SCALE IN SECTS ARE PROBABLY the most important and damaging insect pests of cultivated orchids worldwide, particularly so in greenhouses of northern climates. According to Dekle (1976), there are no fewer than 27 species of scale identified from cultivated orchids, but Chou et al. (1994) listed 71 species of armoured scales and 21 species of soft scales from orchids worldwide. Especially frequent and damaging is the Boisduval scale, which is one of the most serious scale pests on orchids and many other ornamental plants.

Boisduval scale (*Diaspis boisduvalii*) (Hemiptera: Diaspididae) was named in 1869 by the entomologist Victor Antoine Signoret, the father of scale taxonomy to honour M. Boisduval, the collector of the first recorded specimens found on greenhouse orchids at the Jardin du Luxembourg in Paris, France. This insect is now probably the principal scourge of orchid growers, at least in North America and Europe. Boisduval scale is a frequently encountered species in both commercial and personal plant collections, and is probably the most difficult to control pest on orchids. It is one of the main causes for extensive pesticide use in orchid nurseries. Despite the pest importance of this insect, very little detailed attention to its biology has been given to this species since Richard Bohart (1942) took an opportunity to study it.

Boisduval scale is native to tropical America, but is now found globally. This insect was probably widely spread during the orchid craze of the 1800's in the masses of orchids and other plants exported from the Americas, and it found amenable conditions in botanical gardens and greenhouses. Distribution of infested plants remains the primary route of dispersal between collections. Palms are natural hosts, but they are also common on Laeliine and Oncidiine orchids. I once found a small colony of this insect on a twig epiphytic *Oncidium sp.* on the east slope of Volcan Barva in the central mountains of Costa Rica. Cacti, bromeliads, and other plants are also fed upon by Boisduval scale. At least 34 natural and hybrid genera of orchids, including popular genera such as *Angraecum, Cymbidium, Stanhopea, Zygopetalum,* etc., and plants from 17 other families are documented as hosts.

Boisduval scale will seriously debilitate and kill an orchid if not controlled quickly. Upon settling, the insect inserts long, threadlike styli comprised of highly modified mandibles and maxillae into the plant tissues where they feed on cell contents. These feeding styli can be long, up to seven times the length of the insect's body. Injection of toxic saliva, containing enzymes, produces cellular death during feeding. On leaves, even a single scale can produce a more or less circular zone of chlorotic tissue upwards of a centimetre or more away from itself. In general, Boisduval scale feeding creates broad zones of cell death, resulting in chlorosis, necrosis, and overall decline of plant structures. Even one or a few scales can cause damage and make a plant weak or unsaleable. Extensive infestations will kill a plant, in the Bohart study seven females on a cattleya were used to establish a colony that produced over 10,000 scales in five months.

The most common way of acquiring scale is by purchase of an infested plant. Even a plant that appears scale-free may have hidden crawlers or females. Scales are also easily transmitted from infested to clean plants when your plants touch each other and the crawlers move from plant to plant.

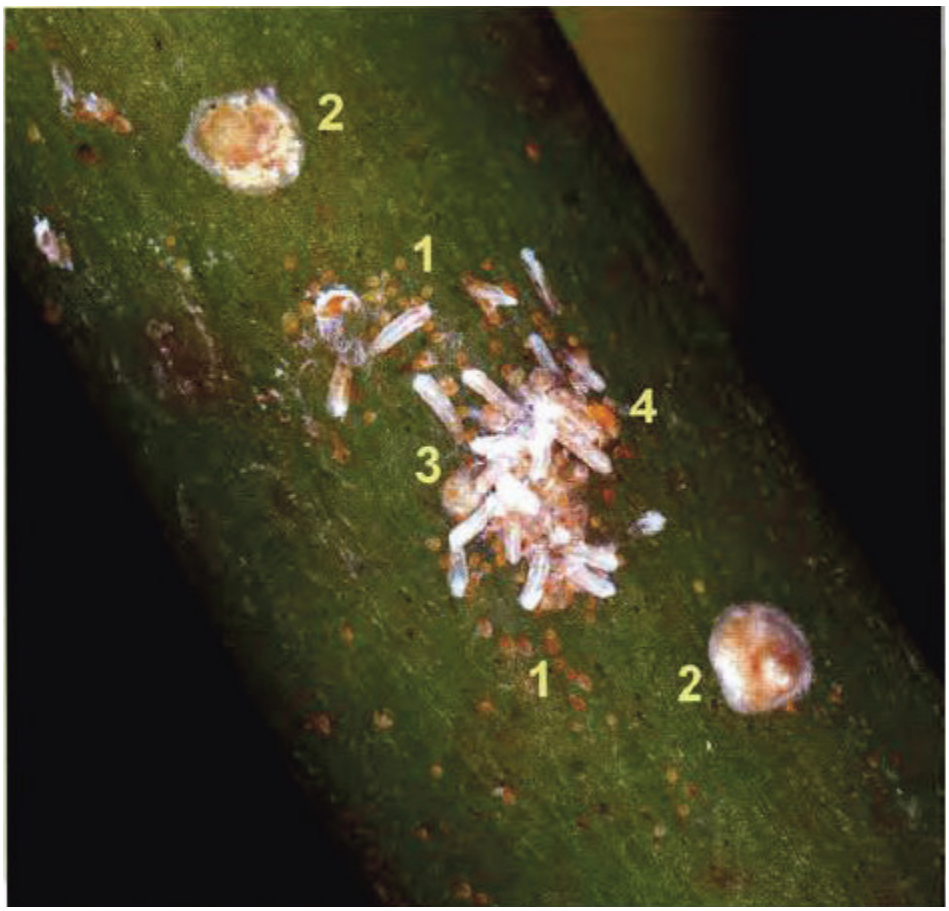


Two newly matured female Boisduval scale developing protective layer along midrib of leaf.

A third source is colonization of your plants by windblown crawlers. Colonization can be done during the summer when your plants are outdoors, but it can also occur indoors and in greenhouses by crawlers floating on air currents produced by circulating and heater fans, or falling from overhead plants. Local pockets of infestation develop when the crawlers settle on plants where the air currents are the weakest. Similar effects are found with aphids, mealybugs, whiteflies, and spider mites. Ants will not move Boisduval scale since it does not produce honeydew or other substances of interest to them.

Life Cycle

Boisduval scale is a peculiar insect, as insects go, but is highly adapted to life as a cryptic parasite of plants. All stages of this species on orchids occur on leaves, petioles, pseudobulbs, rhizomes, and roots. Usually, it is the protective cover, the "scale," of this insect that is spotted first on a plant and is indicative of a pest problem. This cover on maturing and mature females of Boisduval scale is nearly circular and light-coloured, usually translucent light tan to creamy white, about 1.5-2.5 mm across, with a darker central area. Immature male scales are easily recognized by their long and narrow protective covering with three low ridges, and brighter white colour. The males tend to aggregate around receptive females and, when maturing, form a cottony mass which can cause confusion with mealy-bugs at first sight. However, singleton males, when seen without magnification, will appear as a small, fine, white thread-like particle. Mature males are small (0.9 mm), winged, and have orange bodies.



A cluster of Boisduval scale developmental stages:
1) Clusters of crawlers, individuals scattered;
2) Mature females with eggs visible through scale covering;
3) Immature males are white, narrow and elongate;
4) Mature males, yellow-orange.

Boisduval scales have a three-stage life history: egg, larva (or nymph), and adult. Eggs are laid under the female's protective scale covering, and then she dies. The eggs hatch five to seven days after being laid. There are typically only two larval instars. The ambulatory first instar nymphs, called crawlers, are tiny (ca. 0.18 mm in length) pale yellow, and leave the protective cover to find feeding sites. The crawler instar is the active dispersal and least protected instar that moves between plants, rides air currents, and is the most susceptible to control methods. After finding a suitable place for feeding, the crawler will settle, begin feeding and producing the protective cover, and transform into a second nymphal instar. Under its protective cover, the second instar nymph is a pale translucent yellow colour. The covering enlarges as the insect grows and matures, incorporating glandular waxes, nymphal skins, and sometimes debris. The adult female under the cover is also pale translucent yellow.

The sexes are readily distinguished by the shape of their protective covers. The female forms a circular to subcircular slightly domed, waxy covering that provides protection from predators and parasites, and pesticides. In contrast, the immature male forms a narrow, elongate cover with three fine ridges. In well-developed populations, females, males, and immatures will together form clusters or a patchwork of infestation sites.

Individual Boisduval scales have short life cycles, measurable in weeks, but may have a number of generations per year. In a warm greenhouse, the life cycle for

Three mature female and several nymphs on newly infested pseudobulb

females, from egg to egg, is about 50 days although individual life spans will vary depending upon temperature. Eggs hatch within a week of being laid, the crawler stage is about 1.5 weeks in length, and the second instar of the female takes about another week. A mature female may live as long as seven months and produce about 200 eggs. Males have a shorter life cycle of about 3 days from egg to adult.

Management

Boisduval scale management is usually a protracted and serious effort, and never much fun. The overlapping of multiple generations and rapid generation time are significant factors for management and eradication.

All control methods are at their greatest effectiveness against the crawlers, but there is only a fortnight period of effectiveness for each generation. By the time the insects have formed their hardened cover (the scale), it is too late to easily kill those individuals with most pesticide formulations. Also, darker coloured scales indicate already dead females, but these "shells" are usually full of eggs, which are themselves resistant to controls and will spill when the shell is ruptured or removed.

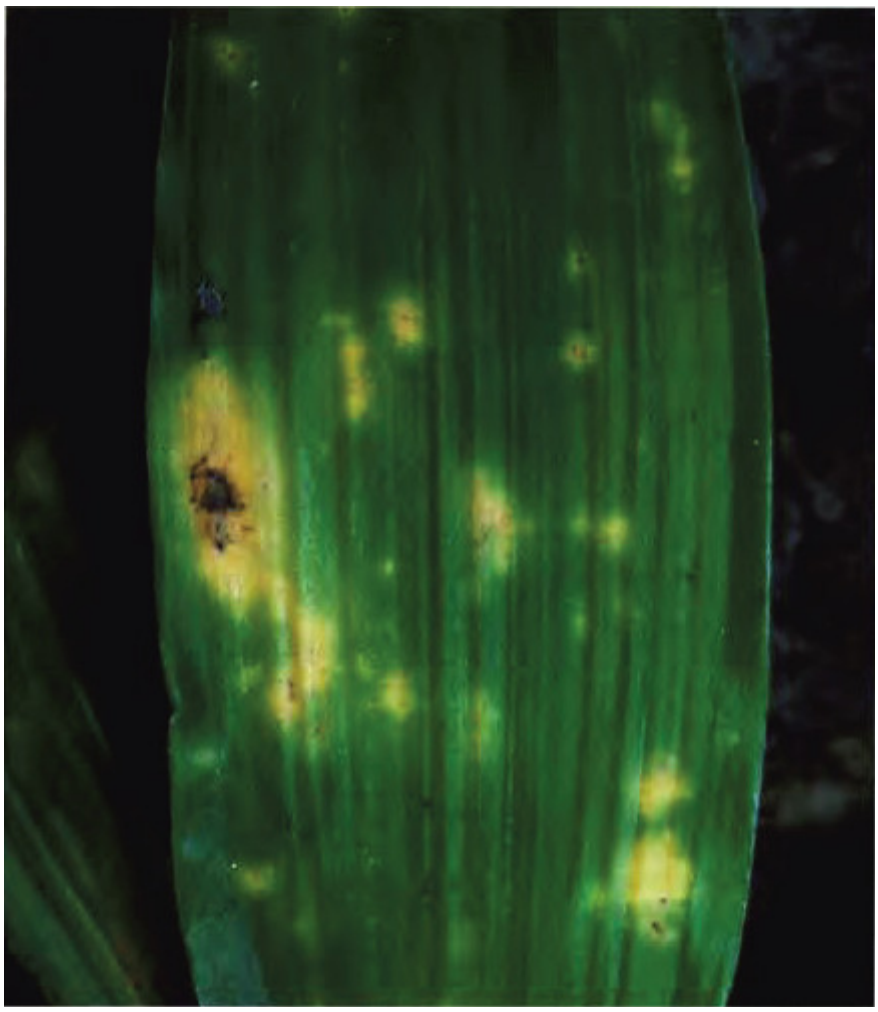
Light infestations restricted to one or a few plants can usually be treated with household products and considerable hand time rather than concentrated insecticides. When possible, immediately isolate infested plants from others to prevent the crawlers from moving amongst them. To bring a serious problem under control you will need to do a treatment every two to three weeks, depending on the life cycle in individual growing conditions and control methods used, because the life cycle of scales can be so short, combined with the overlapping of generations. Consequently, the key factors to scale control are persistence, intensity and regular scheduling of control methods.

Because of plant costs, personal attachment to plants by owners, and well-meaning desires to avoid insecticides, a variety of home remedies for scale control have been developed over the years by hobby growers. Though such methods may be useful for removing the easy to spot insects, be aware that non-insecticidal treatments are not likely to be highly effective for complete elimination of scales. In order to eradicate Boisduval scale, whether one plant or a greenhouse of plants, the grower may find that only the "big guns" will work. Thus, home remedies should be viewed as controls, not necessarily as eradicator methods. Also, many common home chemicals are extremely toxic to humans, pets, and plants even in diluted forms, so due care in judgment of mixing combinations and their use is necessary. Frankly more often than not, it is more effective and efficient to toss a heavily infected plant.

Ventral aspect of *Phaius* leaf showing a heavy infestation & characteristic wilting and curling damage

Biological Control

There are no viable options for biological control of Boisduval scale at this time. Parasitic wasps from several families do attack this scale. Those of the genus *Coccidencyrtus* (Hymenoptera; Encyrtidae) particularly are scale killers, and *C. ochraipes* is known to kill
Boisduval scale in Hawaii and California, and *C. malloi* in Argentina and France. But experimental results in greenhouses are equivocal and these tiny wasps are not generally available commercially. Still, these wasps may be more widely distributed than reported, unrecognized, and may be falling victim to sticky traps and insecticides.
The ladybeetles *Telsimia nitida* and *Lindorus lophanthae* (Coleoptera, Coccinellidae) and a *Cybocephalils sp*. (Coleoptera, Cybocephalidae) are reported to feed on Boisduval scale. I have observed feeding by the convergent ladybeetle (*Hippodamia convergens*) and the otherwise invasive Asian ladybeetle (Harmonia axyridis), but not with significant population reducing effects. Ants (*Pheidole sp.)* may feed on crawlers occasionally but otherwise seem disinterested in Boisduval scale. None of these are reliable for the necessary intensity or duration to eradicate scale from a greenhouse.



Dorsal aspect of a Phaius leaf showing characteristic patchy chlorosis from feeding.

Scales are on underside of leaf.

Generally speaking, biological controls rarely eliminate the pest species, and this is typically the goal of a grower. Further, biocontrol insects are themselves susceptible to pesticide and other control methods. Sometimes, they can become pests themselves. For example, the Asian ladybeetle will feed on orchid blooms too.

Rubbing Alcohol

Probably the most popular and basic home remedy is to swab and daub plants with a cotton-tipped swab or ball of cotton dipped in isopropyl (rubbing) alcohol. Be cautious with other alcohols, such as ethanol, methanol or methylated spirits (denatured alcohol) in a concentrated form, as these can penetrate the plant tissues rapidly and cause considerable damage to soft tissues! These alcohols are used botanically to preserve plant tissues! The concentration of the isopropyl seems to make little difference; the common 70% available in hardware stores and pharmacies is satisfactory. On hard-leaved plants, gentle rubbing with the fingers or a soft toothbrush is effective, with or without the alcohol. Remove all scales, large and small. Afterwards, allow the plant to dry and re-examine it. You may be surprised to find many residual scale bodies, so repeat the alcohol wipe to remove all traces of the insects. Pay particular attention to the midrib, other veins, and leaf edge areas, and do not overlook creases on pseudobulbs or even roots. Because the eggs are hidden under the waxy covering of the dead female, if these are not thoroughly removed remaining eggs will hatch and continue the infestation.

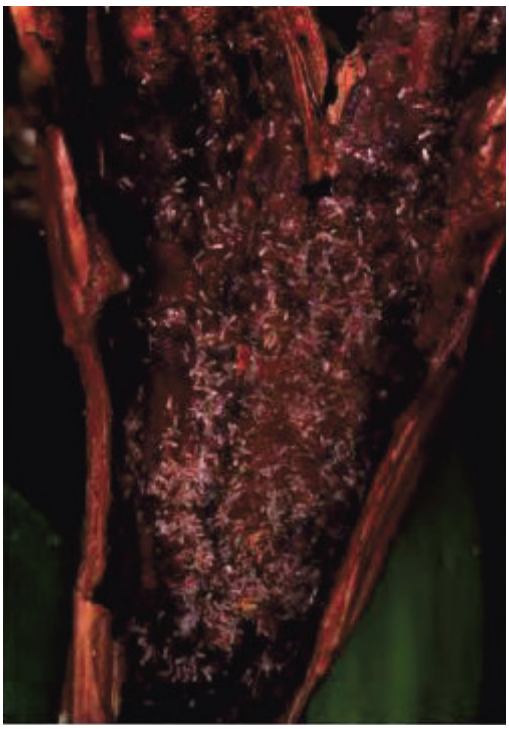
Seven dead female Boisduval scale found under dry bract of pseudobulb on a *Schomburgkia*.

Note rings of removed females with remaining eggs.

A common alternative to the swab and daub method is to spray alcohol with a misting bottle or small pump sprayer. Many home growers will also add a small amount of mild liquid dish detergent, and sometimes mineral oil, neem oil, or horticultural oil. One recipe for a I5 litre spray bottle is to mix a 50:50 solution of isopropyl and water; with a few drops of liquid soap to act as a spreader, and one-half to one teaspoon of one of the oils. But, it seems that every grower has his own proportions of these ingredients, none of which seem to really work significantly better than another. One popular permutation is to mix some Formula 409® into the basic solution, but be sure to use the so-called home use formulations of this cleaner as the industrial formulations may be different and highly toxic to plants. I saw one label for this cleaner that gave quaternary ammonium chloride as the active ingredient. Quaternary ammonium chloride solutions are the same chemicals in commercial kitchen, janitorial, and swimming pool cleaners (see "Sterilants" below).

Regardless of recipe, caution is urged as excessive amounts or too strong a detergent, or use of an ammonia-based chemical cleaner may damage your plants, especially buds and flowers. This is particularly true of strong dish soaps and household detergents that could remove natural protective waxes from plant tissues. Also, alcohol sprays are not effective against eggs protected by the scale covering, hence the physical removal of the scales by hand is more effective and provides more rapid control.

A potential rare problem with alcohol treatment is localized chilling by rapid evaporation of alcohol, especially with air movement that increases evaporative cooling.



A *Schomburgkia* pseudobulb split to show the mass of scale hidden from control methods

This chilling may over-cool tissues and create zones of dead cells (mesophyll collapse) that may subsequently become necrotic from bacteria or fungi.
On warm or breezy days, consider wiping any residual alcohol with a tissue instead of permitting it to evaporate off the plant. Such problems and tissue drying are found particularly on soft, e.g., *Phalaenopsis*, or thin-leafed orchids, e.g., Oncidiines. Repeated alcohol treatment is also suspected in premature leaf yellowing and dropping of leaves, especially on thinner-leaved plants.

Repotting and Trimming

During a severe infestation you may see scale on the roots and rhizomes. At this time, or anytime you observe a heavy infestation, you should consider repotting. The potting medium can harbour eggs and crawlers, so dispose of it appropriately. When repotting, a close inspection and a gentle cleaning of scale and spraying of the roots before repotting is essential. Use care with the cleaning of roots because of their fragility, or simply snip and toss.

Dividing an infested plant to separate more heavily infested parts from other portions, or complete removal of leaves or growths that are infested should be considered. This drastic action does reduce an infestation by removal of the insect, reduces residual eggs and crawlers, and may make it easier to clean and recover the remainder of the plant. Be sure to effectively dispose of the infested plant parts, and wash your hands before touching other plants!

Oils, Soaps, and Sterilants

Horticultural oil, neem oil, mineral oil, insecticidal soaps, and sterilants form the next stage of chemical control of scale insects. This is a middling ground of pest control, between the homespun solutions and full-fledged pesticide warfare! The oils and soaps are often regarded as "organic" or non-chemical methods, but this is often a misconception. Indeed, neem oil is distilled from ground-up neem trees, but horticultural oils and mineral oil are petroleum distillates. Likewise, insecticidal soaps are often, but not always, a solution of synthetic pyrethrins mixed with a detergent or soap that is made from petroleum products. Sterilants are chemical factory products that are antibacterial, anti-fungal chemicals, and often effective on algae. In general, all of these solutions are

generally considered safer for humans, pets, and plants than the more usual insecticides. None provide eradication of pests, but frequent use during the presence of pests may reduce insect populations to below self-sustaining levels in small orchid collections.

Horticultural, mineral, or neem oil solutions smother and asphyxiate the insects, so complete coverage of all sprayed plants is essential. These oils are mixed with water and usually a plant-safe detergent for enhancing the spreading and sticking of the oil. The main caution with these oil solutions is that they should not be applied to plants on hot days (>80°F/>27°C) or in direct sunlight, as to prevent burning of tissues. If possible, leave the plant in shade until the application has dried. Usually mineral or horticultural oils are best, as plant-derived (vegetable) oils may spoil rapidly in heat and create gummy blobs or decay malodorously.

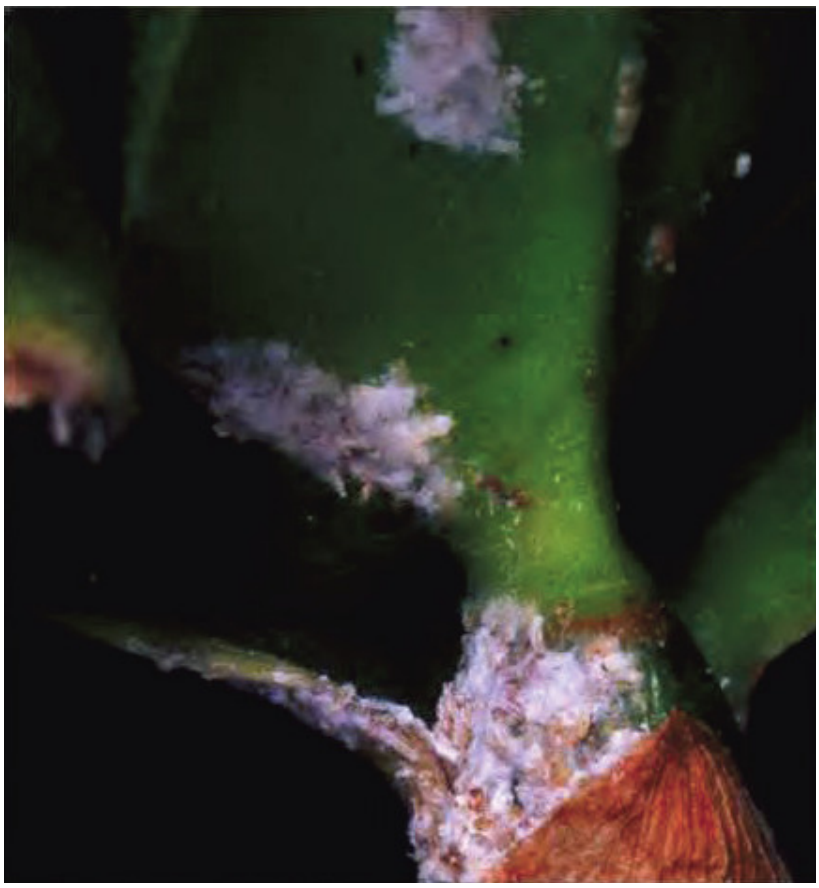
Technically soaps are alkaline potassium salts of fatty acids, while detergents are synthetic compounds that have chemical activity similar to soaps. Soaps react with alkaline compounds containing sodium, potassium, calcium, or magnesium, while detergents are relatively neutral and normally do not form the same reactions in hard water. Insecticidal soaps are usually solutions of a synthetic pyrethrin with piperonyl butoxide as a synergist to enhance the effectiveness of the pyrethrin, and a plant-safe detergent. As with oils, the detergent acts as a surfactant and spreader for dispersing the pyrethrin evenly and as a mild caustic against the insects. Also, to prevent sunburn apply the chemical and allow it to dry in shade. Pyrethrins are synthetic analogs of pyrethrum, the natural extract. Caution should be urged with so-called "sate" insecticidal soaps as some plants are sensitive, particularly tender new tissues, and especially when mixed with hard water. Some non-orchid ornamentals will drop leaves and abort flowers when sprayed with insecticidal soaps, so caution is urged with prized orchids. Though piperonyl butoxide is usually regarded as safe for plants, it can cause allergies and respiratory problems for users and may contribute to phytotoxicity problems.

Sterilants are usually solutions commonly marketed as Physan 2U, RDZU, or Consan 2U, amongst other brand names, and these are used as anti-bacterial, anti-algal, and anti-fungal agents. These solutions are composed of isomeric mixtures of quaternary ammonium chlorides, and all have similar antibiotic activity. Quaternary ammonium chloride solutions are common cleaners used by commercial kitchens, janitorial services, and swimming pool maintenance. They are available in concentrated forms at hardware stores, home repair stores, and commercial janitorial suppliers. These chemicals are used in diluted form, commonly 10% or less depending upon packaged concentration, according to label directions, usually for controlling bacterial and fungal diseases on orchids, and they are generally safe for human and pest contact in diluted form.

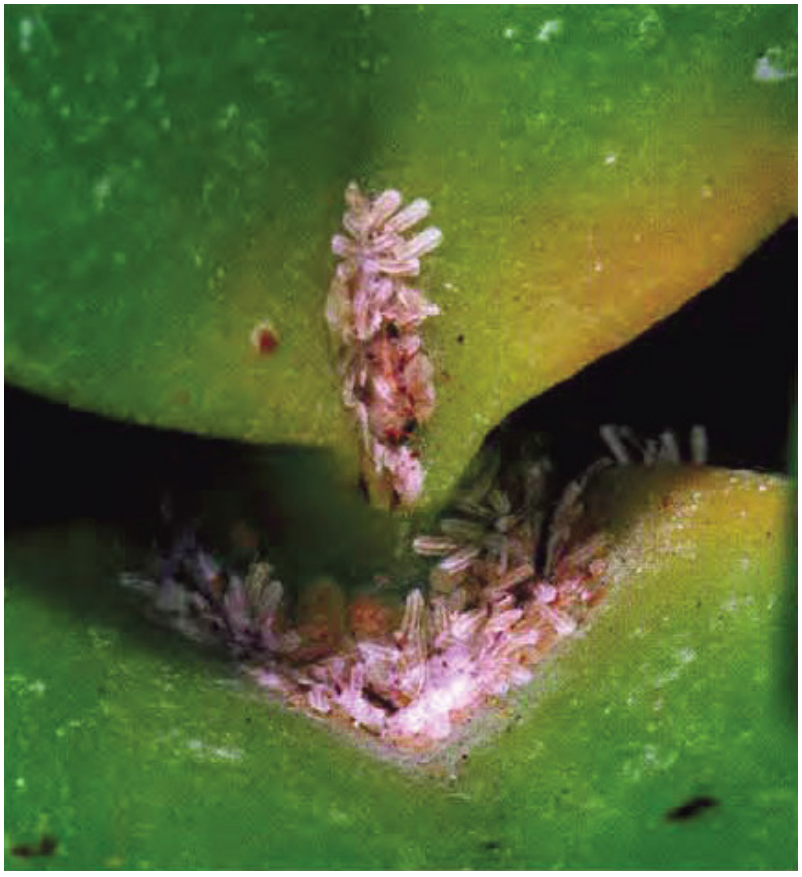
At these same dilutions, there is some effectiveness on scale crawlers and other delicate insects, Quaternary ammonium chlorides also seem to mix well with most insecticides and fertilizers, functioning as a surfactant. But, frequent use of sterilants for insect control is not recommended due particularly to potential damage on new growth, buds, and flowers, and should be done under shade and cooler temperatures to prevent sun and chemical burn.

Insecticides

Severe and persistent populations of scale or infestation in many plants often demand the need for use of synthetic insecticides. There are few insecticides specifically registered for use on orchids, but there are common, inexpensive, home-and-garden chemicals labelled for ornamental plants. The most commonly used and effective insecticides are listed in the adjoining table. Avoid insecticide formulations not labelled for ornamental plants as these are often mixed with solvents that aide in the application of the active ingredient. It is these solvents, not necessarily the insecticide itself, that often produce phytotoxicity and may seriously damage or kill plants.



A leaf underside and upper pseudobulb of a *Sophrolaeliocattlea* hybrid with masses of Boisduval scale.



Leaf bases of a *Sophrolaeliocattlea* with crevices
filled with scale.

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The basic rule: never use any insecticide that is not specifically labelled for ornamental plants.

There are many insecticides available for ornamental plants, but most are not tested specifically on orchids, and others are generally too expensive or otherwise readily available for the small collection keeper. A new insecticide called Safari (dinotefuran) shows great promise for control of scale and other greenhouse pests, but it is currently packaged in 3 lb units for commercial use and is expensive; I received two quotes stating $130/lb! Meanwhile, some of the more available, effective, and usually less expensive insecticides that come in various brand names are given in the adjoining table. Acephate, imidacloprid, and malathion seem to be the most effective for elimination of scale. These all come under a variety of labels and brand names. The recently developed neonicotinoid insecticides, such as fluvalinate and bifenthrin are effective on many pests, but are not labelled for scale and have limited effectiveness. Other chemicals are available, but in some states you may need a commercial license to purchase them. All of these insecticides come in a variety of formulations, such as liquid, wettable powders, suspensions, etc, designed for specific uses, Each formulation and branding varies in concentration, so attention is necessary in selecting an appropriate formulation. One of the more popular and effective insecticides is acephate in a 75% wettable powder formulation, which is usually available at agricultural suppliers and is highly effective on Boisduval scale. A current garden centre insecticide mixture of acephate and the miticide fenbutatin-oxide is inexpensive and effective for many common orchid pests, but has only limited contact poison effectiveness on Boisduval scale.

Of course, always follow label directions and do not greatly exceed the minimum recommended concentration given in mixing directions. Recommended solutions are based on extensive testing for selected pests and plants. Orchids can be sensitive to various chemicals, particularly under direct sunlight or high heat, and while certain species may not react to a given formulation others may so testing is justifiable. More chemical is not always better!

Home orchid keepers in northern states that need to apply insecticides during inclement weather need special care with applications. If you cannot spray out of doors, you could place your plant(s) inside a large plastic bag. Remove the bag after the spray has settled, and let the plant ventilate where the fumes will not be wafted around the house or work area. Careful spraying inside a shower stall that can be washed clown afterward is also effective; be sure to keep the ventilation fan going. Also, consider removing the potting medium, spraying the plant, and repotting it with new media in a clean pot when the spray has dried.

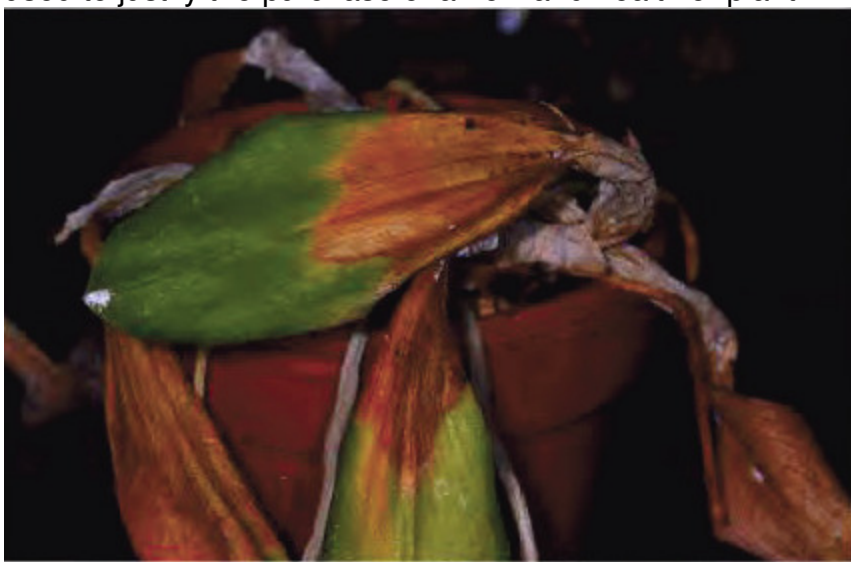
Growth Regulators

Insect growth regulators, such as kinoprene (Enstar II) are synthetic forms of a juvenile hormone which is essential to insects at critical stages of their metamorphosis. The use of growth regulators interrupts the normal development of insects, including orchid pests such as scales, mealybugs, aphids, and whiteflies. Kinoprene does not work effectively on adult insects and should not be expected to eradicate a pest population. It is best used on incipient infestations, and in maintenance sprays, and in conjunction with regular insecticide to break the insects' life cycle and prevent nymphs from maturing.

Azadirachtin is derived from the neem tree. This is the active chemical in unpurified neem oil and marketed as a botanical insecticide, and is not found significantly in clarified neem oil. Azadirachtin is an ecdysone hormone analogue and inhibits chitin production and deposition. Chitin is a primary component of the insect integument, or exoskeleton. Azadirachtin reduces the insect's ability to properly develop its integument and causes mortality through incomplete development.

Final Considerations

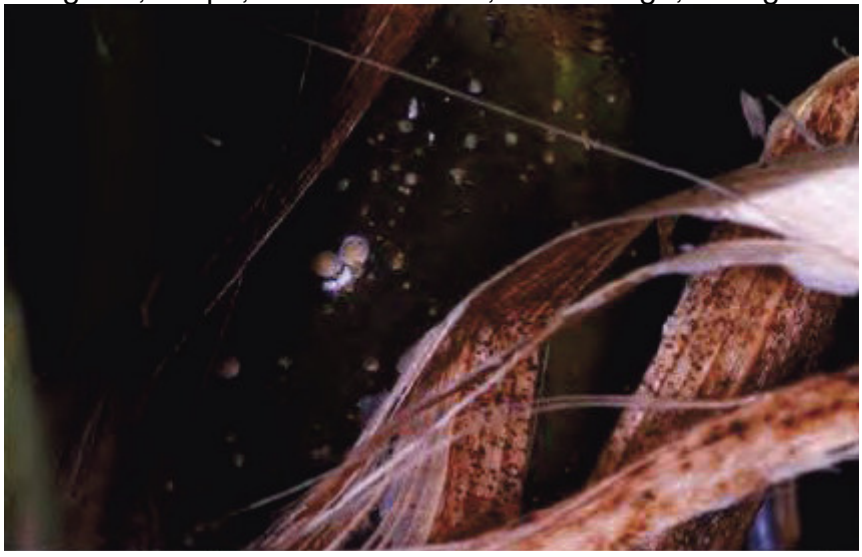
Heavy infestations of scale, especially on many plants, will require control methods over a long period of time. In such situations, you may need to consider the use of a synthetic insecticide. On the extreme side, if you have a plant showing signs of decline from scale, you may have to seriously consider destroying that plant as a low likelihood of rejuvenating that plant may not justify the expense and effort of continued treatments, or risk infestations to additional plants. After all, the destruction of a sick plant can be used to justify the purchase of a new and healthier plant!



A *Sophrolaeliocattlea* that died from scale

If you are battling scale for long periods of time (eg., >9 months) and have been using the same insecticidal control method then you may have built a bigger problem. Depending on the length of time of your problem and the intensity of chemical treatments used, you could have selected a population of resistant scales. The best resolution to this is to change methods and chemicals occasionally. That is, do not use the same chemical mix more than three-four times sequentially. After isolating infested plants give them a thorough application of something different from what you have been using. For example, if you used a particular insecticide, then switch to an oil, soap, or different insecticide. In a small collection, hand-clean the plants whenever possible to remove scales. Remember, even an apparently dead female may still have viable eggs under her shell.

Generally, never use an insecticide not labelled for ornamental plants. Whenever using oils, soaps, and insecticides, be thorough, change formulations frequently, and do



A pseudobulb of a *Stanhopea* showing multiple stages of scale that were hidden beneath the bracts.

not use less than the minimum concentration of mixture. Too little of a chemical reduces effectiveness and enhances resistance, while too high of a concentration may damage the plant. Remain aware of potential effects of carrier solutions as well as active ingredients. Avoid using chemicals prophylactically; do not routinely use chemicals as a preventative as it is a waste of the chemical and money, and such use allows resistant scales to develop. Keep up the manual removal of all scales, it possible, since removing the adults is as important as killing the nymphs. Remove dead scales because eggs protected under the shell of the dead female may hatch and re-infest the plant. The single greatest problem leading to unsuccessful scale management is lack of patience and lack of attention to scheduling. It takes time to eliminate a scale population, even with intensive and regular control methods, and there still may be no guarantee of eradication. Finally, regular attention to your plants will allow recognition of new infestations and these are easier to eradicate successfully. ✿

References

Beardsley, J.W., Jnr. and R.H. Gonzalez. 1975. *The Biology and Ecology of Armoured Scales*. Annual Review of Entomology, 20: 47-73.

Bohart, R.M. 1942. *Life history of Diaspis boisduvalii and its control on Cattleya with calcium cyanide*. Journal of Economic Entomology, 35: 365-368.

Chou, S.K., R. Ernst, J. Arditti, and C.S. Hew. 1994. *Orchid Pests — A Compendium*, pp. 455-563. In: J. Arditti (ed.), Orchid Biology; Reviews and Perspectives, VI. New York: John Wiley & Sons, Inc. xv+610 p.

Dekle, G.W. 1976. Florida armoured scale insects. Revised edition. *Arthropods of Florida and neighbouring land areas.* Volume 3. Florida Department of Agriculture and Consumer Services, Gainesville. Florida, USA, 345 pp.

Espinoza, A., H. Bowman, A. Hodges, and C. Hodges. 2009. Boisduval scale, *Diaspis boisduvalii* Signoret (Insecta: Hemiptera: Diaspididae). http://edis.itas.ufl.edu/in838. [accessed 04 March 2010]

ExToxNet: Extension Toxicology Network. 2010. http://extoxnet.orst.edu/ [accessed 20 March 2010]

Gill, R.J., 1997. *The scale insects of California. Part 3*. The armoured scales (Homoptera: Coccoidea: Coccidae).Technical Series in Agricultural Biosystematics and Plant Pathology No. 3. California Department of Food and Agriculture, Sacramento, California, USA. 307 pp.

Miller, D.R. and J.A. Davidson. 2005. *Armoured scale insect pests of trees and shrubs (Hemiptera: Diaspididae).*Ithaca: Cornell University Press. 456 p.

ScaleNet. http://www.sel.barc.usda.gov/scalenet/scalenet.htm [accessed 04 March 2010]

Tenbrink, VL. and A.H. Hara 1992. *Diaspis boisduvalii* (Signoret). http://www.extento.hawaii.cdu/kbase/crop/type/d_boisdu.htm. [accessed 04 March 2010]

Watson, G.W. 2005. *Arthropods of Economic Importance-Diaspididae of the World*. http://nlbif.eti.uva.nl/bis/diaspididae.php [accessed 04 March 2010]

Watson, J.B. (ed.): 2002. Orchid *Pests and Diseases*. Florida: American Orchid Society; Delray Beach. 124 p.

Insecticides and Other Chemicals Useful for Control of Boisduval Scale

Insecticide	Trade Names	Usual Application
Acephate*	Orthene & others	spray
Azadirachtin	Azatin & others	spray
Dinotefuran*	Safari	spray
Imidacloprid*	Merit, Provado, & others	spray, drench
Bifenthrin	Talstar& others	spray
Carbaryl	Sevin & many others	spray, dust
Diazinon (commercial only)	many brands	spray
Fluvalinate	Mavrik& others	spray
Insectidal soap	many brands	spray
Isopropyl	rubbing alcohol	spray, topical by hand
Kinoprene*	Enstar II	spray
Malathion*	Malathion & others	spray, drench
Oils (neem, mineral, etc.)	many brands	spray, topical by hand

* denotes greatest effectiveness for potential eradication on orchids.

About the Author

Paul J. Johnson, Ph.D., lives in rural eastern South Dakota where he is a professor of entomology and curator of the Severin-McDaniel Insect Research Collection at South Dakota State University, Brookings, SD. He has studied insects and general natural history since childhood and did three degrees in entomology at Oregon State University, the University of Idaho, and the University of Wisconsin-Madison. Most of his research is on click beetle taxonomy and biodiversity, but he diverges into other insects, native orchids, and tropical biology. He teaches undergraduate Insect Biology and graduate classes, and leads student trips to Costa Rica and Bolivia to study bioluminescent click beetles, orchid bees, and other natural history phenomena. Growing and breeding *Coelogyninae* and *Stanhopea* orchids in his self-designed and built greenhouse is a weekend hobby.

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