

LONG-TAILED MEALYBUGS ON ORCHIDS

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MEALYBUGS ARE CURIOUS insects. Like scales, aphids, and other small but highly evolved hemipterous insects, mealybugs have many traits that express their specializations for a parasitic life on plants. Unfortunately, because of their natural success as plant parasites certain mealybugs are also among the most serious pests of orchids. The ScaleNet website notes the presence of at least 2000 species of mealybug worldwide, with 300 species in the United States and Canada, alone. According to identification records kept by the Systematic Entomology Laboratory, U.S. Dept. of Agriculture, 39 species of mealybug are reported from orchids. Fortunately, only a few species are regularly problematic on orchids, but which species occur where varies considerably. Of the species possible on orchids, the long-tailed mealybug in particular is probably the most pernicious and persistent pest of orchids in homes and small greenhouses, after the Boisduval scale.

The long-tailed mealybug (*Pseudococcus longispinus*) was described by the Florentine physician turned entomologist Adolfo Targioni Tozzetti in 1867. Targioni Tozzetti specialized in insects that are now classified as the Sternorrhyncha, now a Suborder of Hemiptera (formerly in Homoptera), that includes the scale insects, mealybugs, aphids, and related insects. He was particularly interested in the pestiferous species and recognized that the long-tailed mealybug was fast becoming distributed worldwide through horticultural and agricultural plant movements. Because this species has a broad host range, wide distribution, and abundance on woody crops and ornamental plants this species is one of the most studied horticultural pests on woody crops, but remains rather poorly studied for greenhouse horticulture.

The origin of the long-tailed mealybug is unknown but it is most probably native to tropical and subtropical America. It is now found globally. Targioni Tozzetti noted that this species was already widely distributed during the 1800's, probably because of the horticultur-

al crazes when masses of orchids and others plants were shipped to Europe and around the world. Quite evidently, it found amendable conditions in botanical gardens, conservatories, greenhouses, and home parlors. Distribution of infested plant materials remains the primary route of dispersal between collections. This insect does occur out-of-doors year around from warm-temperate to tropical environments. Growers living at middle to higher latitudes often move it indoors as plants summering outside are brought back in.

A major problem with the long-tailed mealybug is its broad acceptance of many host plants. McKenzie (1967) listed plants from 23 families, including Orchidaceae. A list of plants that are good for maintaining mealybug populations would be extensive.



Mealybug crawling on pot.



Cluster of adults and immatures on *Phalaenopsis* leaf.

Tenbrink and Hara (1993) listed 31 common Hawaiian plants as hosts. Some common and widespread houseplants that are favorites of the long-tailed mealybug include croton, palms, hibiscus, poinsettia, crassula, philodendron, dracaena, tradescantia, cacti, pothos, spider plants, ivy, chinese evergreen, gesneriads, banana, heliconia, and on and on. Probably all species of orchids are susceptible to mealybugs, especially when cultivated indoors such as *Cymbidium*, *Oncidium*, *Phalaenopsis*, *Paphiopedilum*, *Phragmipedium*, *Zygopetalum*, and others. *Phalaenopsis* species and varieties are

particularly susceptible to long-tailed mealybug.

Mealybug feeding generally will not seriously debilitate a plant when at low populations, but they are bothersome to most persons, and an infestation can grow quickly. Mealybugs are phloem feeders and move frequently from site to site. This type of feeding does not normally cause distinctive chlorosis except from high densities. Still, the damage done to plants by mealybugs can be considerable, causing a loss of vigor and growth, spotting, curling, wilting, stunting, loss of leaves, buds, and flowers, premature senescence, and general unthriftiness through their feeding. In addition, mealybugs can produce honeydew that make plant parts sticky and provides a substrate for sooty mold, but is of little interest to ants. Though some mealybugs vector plant viruses on grapes and other plants, apparently no orchid virus transmission by the long-tailed or other mealybugs has been demonstrated or otherwise verified.

The long-tailed mealybug can be found on all plant

combination of three methods: purchase of an infested plant, movement from infested to uninfested plants that are in contact with each other, and windblown colonization. Mealybugs are active and will crawl up and down a plant, from one plant to another, pot to pot, across benches, or drop from hanging plants. Mealybugs will leave plants and hide under rims of pots and trays and bench crevices. Spread of crawlers can occur both indoors and outdoors by floating on breezes or air currents produced by circulating and heater fans. The occurrence of infestation hotspots may be due to crawlers settling on plants where the air currents are the weakest. Similar effects are found with aphids, scales, and spider mites.

Identification

Mealybugs are classified in the family Pseudococcidae, and are closely related to the scale insects. In fact, entomologically speaking, mealybugs are best thought of as a kind of soft scale that does not form the protective cover that most scales produce for protection.

Mealybugs are generally easy to identify insects in the greenhouse arthropod panoply. They are the only common greenhouse pests that have an oval body that is soft and plump, is ambulatory, covered with a waxy and mealy textured bloom, and has thin filaments extending from the posterior end and sometimes along the sides. Immature long-tailed mealybugs measure from about 0.2 mm to upwards of the adult length of 2.5 mm, with the caudal filaments doubling or more the apparent body length as they grow. The more common species of these odd insects that infest orchids are immediately recognized in the adult stage by the white, yellowish-white, whitish-grey, or

pale pink coating. The long-tailed mealybug is usually distinguished by the presence of 4 long filaments extending from the posterior end of the body, with a shorter middle filament. These filaments sometimes give the impression of numerous legs, especially if broken and shortened.

Other than the long-tailed mealybug, species reported from major orchid growing areas are six other species of *Pseudococcus*, the two orchid mealybugs (*Pseudococcus microcirculus* and *P. dendrobiorum*), imported mealybug (*P. importatus*), obscure mealybug



Sooty mold spots on *Phalaenopsis* petal.



Massed adults on *Phalaenopsis* rachis.

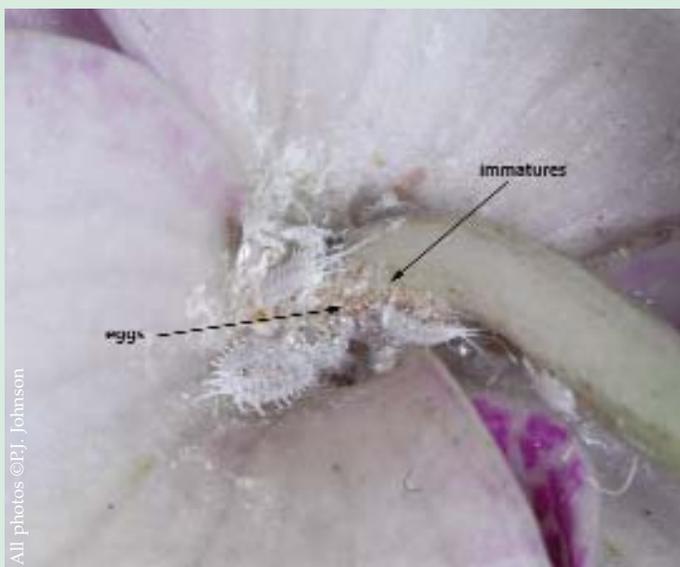
parts, but especially in crevices, folds, curls, joints, sheaths, overlapping leaves, and other tight places. In large part it is this secretive behavior that makes them difficult to control. They are also adept at hiding on roots and rhizomes deep in the potting media, and away from the plants on shelving and pots. Unlike sedentary scales, mealybugs wander in search of feeding places and will leave plants so be sure to check for them in cracks and in joints on benches, under lips of pots and trays, and other hiding places.

Orchids become infested with mealybugs in some

(*P. obscurus*), grape mealybug (*P. maritimus*), Jack Beardsley's mealybug (*P. jackbeardsleyi*), and the pineapple mealybug (*Dysmicoccus brevipes*) and solanum mealybug (*Phenacoccus solani*). These various species are recorded from orchid growing centers around the world in tropical, subtropical, and warm temperate areas, but only the long-tailed mealybug seems common and widespread on orchids in greenhouses. The species-level identification of most mealybugs is difficult and often requires the services of a taxonomic entomologist specializing on these insects. Because of the identification difficulty accurate information on the identification and biology of species that may infest orchids is much poorer than one would hope. Fortunately, the long-tailed mealybug is relatively easy to identify species in a greenhouse environment due to its commonality and the very long caudal filaments that characterize this species.

ing the illusion of live birth.

After hatching, the crawlers wander away from their mother to seek new feeding areas. They are flattened, oval, light yellow, and with smooth bodies. Soon after beginning to feed, they exude a white, waxy covering over their bodies, giving them their mealy appearance. Male crawlers stop feeding near the end of the second stage and migrate towards a protected place where they spin waxy cocoons in which they quickly complete development, emerging as a tiny (ca. 1.5-2.5 mm) fly-like creature that does not feed. In contrast, the female goes through three immature stages, being mobile and feeding throughout, but changes little in appearance other than growing larger, reaching upwards of 5-6 mm (ca. 0.2") in length. Developmental periods vary with temperature, but at a constant 70°F (21°C) the time from egg to adult is about one month. Developmental times are lengthened in cooler temperatures, and long-tailed mealybugs are tolerant of cold,



Mealybugs at flower base of *Phalaenopsis*.



Mealybug cluster hidden between leaves of *Phalaenopsis*.

Life Cycle

Mealybugs in general have a three-stage life history: egg, larva (nymph or crawler), and adult (McKenzie 1967). Eggs are straw yellow at first and deepen in color before hatching. Fewer eggs are laid when it is very hot or cool, with 77°F (25°C) being optimum, a good temperature for orchid growth. In laboratory conditions 20 to 240 eggs have been observed per female (El-Minshawy *et al.* 1974). Eggs are normally laid within a waxy egg sac produced by most female mealybugs species, but when eggs are laid by the long-tailed these are loose but clustered under the body of the female. In the early literature it was thought that the long-tailed mealybug produced live larvae at birth, suggesting parthenogenesis, but close subsequent study revealed that eggs simply hatched quickly after laying, thus giv-

ing the illusion of live birth. In contrast, development is accelerated in warmer temperatures. Though males find mates quickly after emerging, conduct their duty, and die, individual females may live 2-3 months and produce eggs frequently. In temperate regions, mealybugs usually have only one or two generations per season out-of-doors. But, in a warm greenhouse or on houseplants there may be eight or more overlapping generations per year.

Management

Outdoor mealybugs are vulnerable to a variety of parasitic and predatory insects, including wasps, brown and green lacewings, and lady beetles. Weather, especially heavy rains, also help keep mealybug populations low. However, because of long-tailed mealybug

tolerance for cool temperatures plants kept outdoors for a growing season can be expected to bring the insects with them indoors. Combine this with the developmental time, it is not unusual to have a mealybug population explosion in late autumn long after it is forgotten that the plants were naturally infested during the summer.

Indoors, mealybug management is difficult because of their propensity to move into the potting medium, or for the crawlers and adults to work their way into tight and cryptic places. Repeated application of any treatment is required to eliminate a population. Unlike scales, both mealybug crawlers and adults are susceptible to most control methods. Hand removal is effective for adults and larger nymphs.

All control efforts must begin immediately following discovery. Even light infestations restricted to one or a few plants can explode rapidly. When possible, immediately isolate plants brought indoors or other-



Mealybugs hidden inside floral clip.

wise infested plants from others to prevent the mealybugs from moving amongst them. Also, check the lips and cracks of pots, trays, and benches because females will wander and leave the plant to find hiding places. If plants other than orchids are grown, check those also as they are a likely source of infestation.

Because the life cycle of mealybugs can be short in warm temperatures combined with the overlapping of generations, you will need to do a treatment at least every two weeks in order to bring a serious problem under control. Fortunately, mealybugs are relatively easy to kill with effective "home remedies", but to deal with an established infestation the use of an insecticide will likely be necessary. Be aware that non-insecticidal treatments are often not very effective for elimination of mealybugs without diligent application and follow-up treatments.

Biological Control

Though there are many parasitic wasps and various predatory insects that feed on mealybugs outdoors, none are really effective options for control of mealybugs in a small greenhouse or in the home, if pest eradication is a goal. This is largely due to the intense desire of growers to have a pest-free plant area and frequency of insecticide use. However, the keeper of many plants in a large greenhouse or a commercial grower may wish to consider the use of one or more parasitic or predatory insects to help keep mealybugs under control. As in all biological control efforts eradication is generally not possible. Also, anyone wishing to use biological control agents needs to balance their use with proper timing or avoid the use of insecticides so as not to kill the beneficial insects.

Biological control species include a variety of tiny parasitic wasps (e.g., *Anarhopus sydneyensis*, *Hungariella peregrina*, *Tetracnemus peregrinus*, and *Anagyrus fusciventris*; Hymenoptera, Encyrtidae); minute pirate bugs (*Orius*; Hemiptera, Anthocoridae), brown lacewings (*Hemerobius*; Neuroptera, Hemerobiidae), green lacewings (e.g., *Chrysopa oculata*, *Chrysoperla ploribunda*; Neuroptera, Chrysopidae), gall flies (e.g., *Dicrodiplosis californica*; Diptera, Cecidomyiidae), lady beetles (e.g., *Scymnus*, *Nephus*, *Hyperaspis*, *Lindorus lophanthæ* and *Cryptolaemus montrouzieri*; Coleoptera, Coccinellidae), and various spiders. Montrouzier's lady beetle, also known as the mealybug destroyer, is highly effective for control of mealybugs outdoors and in greenhouses. Many of these species may be present in low-insecticide greenhouses, but would still fall victim to sticky traps and insecticide treatments. Few of these biocontrol species are available commercially, but naturally occur in many areas.

Rubbing Alcohol

Probably the most popular home remedy against mealybugs is to swab and daub plants with a cotton-tipped swab or ball of cotton dipped in isopropyl (rubbing) alcohol. Avoid using other alcohols, such as ethanol or methanol in high concentrations, as these can penetrate the plant tissues and cause considerable damage! After all, these alcohols are used to preserve and pickle plant tissues. The common 70% isopropyl available in stores is satisfactory when used with a cotton ball, cotton-tipped swab, or a soft infant's toothbrush. Remove all mealybugs, large and small. Pay particular attention to the folds, crotches, branch bases, midrib areas, and roots where mealybugs secrete themselves. Spraying the alcohol with a misting bottle or small pump sprayer is effective, but dribbling alcohol into tight areas is necessary and a mild detergent is helpful. To avoid getting a spray solution on windowsills, table tops, furniture, non-target plants, etc., move the plant(s) to a large sink, bathtub, or shower stall,

then move them back to the growing area when they dry. The waxy fluff on mealybugs will often adhere to plant parts after death of the insect, but good a rinse under a tepid shower helps remove these residues.

Many home growers will mix with alcohol a small amount of mild liquid dish detergent, and sometimes mineral oil, neem oil, or horticultural oil. One recipe for a 1.5 liter spray bottle is to mix a 50:50 solution of isopropyl and water, with a few drops to about a teaspoon of liquid soap to act as a spreader, and a teaspoon of one of the oils. But, it seems that every grower has favorite proportions of these ingredients, all of which seem to work effectively. 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. Some formulations use a quaternary ammonium chloride solution as the active ingredient. Quaternary ammonium chlorides are the same chemicals in commercial kitchen, janitorial, and swimming pool cleansers and should be diluted appropriately (see "sterilants" below).

Regardless of recipe, caution of use is urged, however, as excessive amounts or too strong a detergent, or use of an ammonia-based chemical cleaner may damage your plants, particularly buds and flowers. This is particularly true of dish-soaps and household detergents that could remove natural protective waxes from plant tissues. Also, spraying of alcohol is not always effective against mealybug eggs, especially if hidden, hence the need for thoroughness and repetition.

Repotting

Even a light to moderate infestation of mealybugs should be of concern. These insects like to move into the potting media and may feed on rhizomes or roots, or move off of the plant to find hiding places to lay eggs. Unless the roots are checked and the media changed, removal of mealybugs from only the upper plant portions is not a guarantee of success. The potting medium can harbor eggs, crawlers, even adults, so dispose of it in a compost pile or in the garbage.

Oils, Soaps, and Sterilants

Horticultural oil, neem oil, mineral oil, and insecticidal soaps are effective for mealybug suppression. The oils and soaps are often regarded as "organic" or non-chemical methods, but this is 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 a solution of synthetic pyrethroids mixed with a mild detergent that is made from petroleum products. Sterilants are chemical-factory products that are anti-bacterial, anti-fungal, and anti-algal. In general, all of these solutions are gen-

erally considered safer for humans, pets, and plants than the more usual insecticides. Rarely do any of these provide eradication of mealybugs, but frequent use can serve to reduce their populations dramatically.

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 never be applied to plants on hot days (>85° F / >27°C) or in direct sunlight, as to prevent burning of tissues. 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



Paphiopedilum petiole with mealybug infestation exposed by exerted bud.

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 sunburning apply the chemical and allow it to dry in shade. Pyrethroids are synthetic analogs of pyrethrum, the natural extract. Caution should be urged with so-called "safe" insecticidal soaps as some plants are sensitive, particularly tender new tissues, and especially mixed with hard water. Some non-orchid ornamentals will drop leaves and

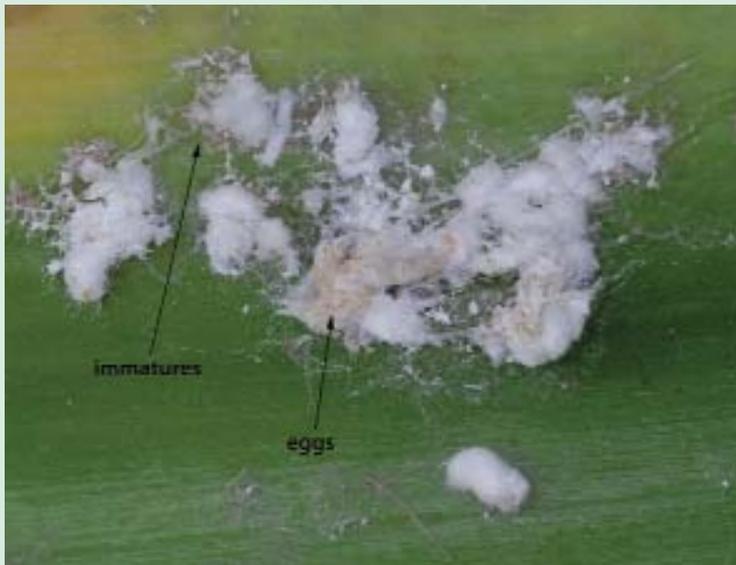
abort flowers when sprayed with insecticidal soaps, so caution is urged with prized orchids. Though piperonyl butoxide is usually regarded as safe for plants, it can cause allergies and respiratory problems for users and may contribute to phytotoxicity problems.

Sterilants used on orchids are usually solutions commonly marketed as Physan 20®, RD20®, or Consan 20®, 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, usu-

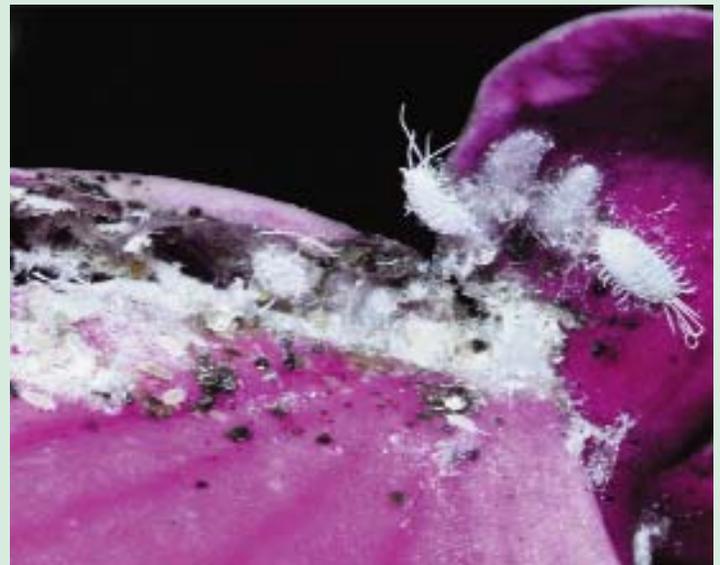
ally for controlling bacterial and fungal diseases on orchids, and they are generally safe human and pest contact in diluted form. At these same dilutions, there is some effectiveness on mealybugs, especially the crawlers. Quaternary ammonium chlorides also seem to mix well with most insecticides and 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.

thetic insecticides. There are few insecticides specifically registered for use on orchids, but there are several common, inexpensive, home-and-garden use pesticides labeled for ornamental plants. The most commonly used and effective insecticides are listed in the adjoining table. Avoid insecticide formulations not specifically labeled for ornamental plants as they are often mixed with solvents that aid in the application of the active ingredient for specific purposes. It is these solvents, not necessarily the insecticide itself, that often produce phytotoxicity and may seriously damage or kill plants. The basic rule: never use any insecticide that is not specifically labeled 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 otherwise readily available for amateur growers. A new, but expensive, insecticide called Safari® (dinoterfuran) shows great promise for control of many greenhouse



Cottony masses of eggs and immatures.



Massed mealybugs between petals and sepals, with sooty mold spots.

Insecticides

Persistent populations of mealybugs or infestation in many plants may demand the need for use of syn-

pests, including mealybugs. Less expensive insecticides that come in various brand names are given in the adjoining table. Acephate, imidacloprid, and Malathion®, are among the most effective for controlling mealybugs, but pyrethrins, pyrethroids, and rotenone can also be effective. The recently developed neonicotinoid insecticides such as fluralaner and bifenthrin are effective on mealybugs and many other orchid pests. The various insecticides listed come in a variety of formulations, such as liquid, wettable powders, flowables, suspensions, etc. Each formulation and branding varies in concentration, so attention is necessary in selecting an appropriate formulation. A current garden center insecticide mixture of acephate and the miticide fenbutin-oxide is inexpensive and effective on mealybugs.

Insecticides and Other Chemicals Useful for Control of Mealybugs

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

* denotes greatest effectiveness for potential eradication

** Dip plants only in well ventilated areas and wear mask

Though many of the available insecticides have various degrees of persistence and “systemic” action, in my experience none really provide the level of systemic activity that senior growers remember from the organophosphate days of chemicals. For example, acephate has such characteristics to a slight degree, but imidacloprid though described as having systemic persistence has little lasting effectiveness on common orchid pests. Whether this is the nature of the chemical, threshold tolerances by the insects, or attributes of our plants need critical investigation.

Of course, always follow label directions and never exceed the minimum recommended concentration given in mixing directions! Recommended solutions are based on extensive testing for selected pests and plants. Orchids are often tough plants, but are sensitive to many 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, 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 down 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 metamor-

phosis. The use of growth regulators interrupts the normal development of insects, including orchid pests such as mealybugs, scales, 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 a regular insecticide to break the insects’ life cycle and prevent immatures from developing.

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 analog and inhibits chitin productions and deposition. Chitin is a primary component of the insect integument, or exoskeleton. Azadirachtin reduces the insects’ ability to properly develop its integument and causes mortality through incomplete development.

Final Considerations

Heavy infestations of mealybugs, especially on many plants, may require severe control methods using insecticides. Fortunately, mealybugs are much more readily discovered and are much easier to control than some other orchid pests.

If you are battling mealybugs for long periods of time (e.g., >9 months) and have been using the same insecticidal control method then you may have developed a resistant population. The best prevention for this is to change methods and chemicals occasionally; that is, do not use the same chemical mix more than three to 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 insecticide then switch to an oil, soap, or different insecticide. Resistance is not generally a prob-

lem with growth regulators, such as kinoprene. In a small collection thoroughly hand-clean the plants when possible.

Generally, never use an insecticide not labeled for ornamental plants. Whenever using oils, soaps, and insecticides, be thorough, change formulations frequently, and do not use less than the minimum concentration of mixture, or more than normally recommended. Too little of a chemical enhances resistance, while too high of a concentration may damage the plant. Do not use chemicals prophylactically when pests are not present, that is do not routinely use chemicals as a preventative as it is a waste of chemical and money, and such use allows resistant mealybugs to develop. Finally, keep up the manual removal of all mealybugs, if possible.

Mealybugs are an excellent example of pests that are easily transported on a wide variety of plants. Remain aware that a recurring infestation may be coming from non-orchid plants, especially other houseplants. As with other pests, patience is necessary for successful control. Finally, regular attention to your plants will allow recognition of new infestations, and these are much easier to eradicate successfully.*

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