SPIDER MITES AND OTHER ACARINA ON TREES AND SHRUBS[1]

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Many people, including professional arborists, tend to think of mites as a single problem generally categorized as "red spider." This is a gross oversimplification that is misleading and may contribute to ineffective application of control measures. There are many kinds of mites with different host preferences, seasonal developmental periods, habits, and types of damage. In addition, there are mites that are predators of other mites and insects, as well as scavengers that play a general role in the natural breakdown of organic matter.

The purpose of this presentation is to identify, describe and characterize the major species of mites associated with trees and shrubs with minimal technology to help arborists achieve more effective control. Basic knowledge of the characteristics and habits of mites is essential in protecting valuable environmental-ornamental plants.

All mites, which are close relatives of spiders and distant relatives of insects, are classified in one order (Acarina), much the same as all beetles are classified in the order Coleoptera, for example. Of the more than 150 families of mites that are known, only a few are of major importance in relation to trees and shrubs. The most important is the spider mites family (Tetranychidae), all of which are plant feeders. The gall rust, blister and bud mite family (Eriophyidae), which includes hundreds of species that are plant feeders, is diverse and commonly represented on most kinds of trees and shrubs. However, the majority are of minor importance because they are not destructively abundant. The false spider mite family (Tenuipalpidae) includes several destructive species. A few other plant-feeding families are occasionally encountered, including the cyclamen mite on herbacious plants, and bulb mites on bulbs, rhizomes, etc., but the Tetranychidae and Eriophyidae are the two major families of tree and shrub pests. In addition, it is important to remember that there are predacious mites which help in the natural control of pest species (mostly in the family, Phytoseiidae).

General characteristics of mites

Plant mites are extremely small, ½ mm or less in length, requiring a hand-lens or other magnifier to determine their presence, stages, and relative numbers, as well as if alive, dead, or gone. Injury alone is not sufficient evidence to determine the need for control measures. They do not have wings, nor a true head or abdomen. There are 4 pairs of legs (except 2 pairs in the Eriophyidae) and, in most cases, one pair of leg-like palps associated with the mouthparts. The mouthparts consist primarily of a pair of needle-like structures for piercing host tissue, allowing the mouth to suck up contents of the damaged cells in the foliage. The feeding mechanism will be discussed in more detail later. Mites generally have an egg stage, several immature developmental forms (nymphs), and adult females and males. Males are not essential to reproduction by females and in many cases may be lacking. Although mites are rather simple animals structurally, they have eye spots, highly sensitized hairs and spines, and other structures that are able to detect and react to touch, light, and chemical stimuli.

SPIDER MITES (Tetranychidae)

Spider mites are so-called because of their ability to spin silken strands as do spiders. However, the silk glands in mites are located near and associated with the mouthparts. From a practical point of view, the silken-producing habit has two important applications: first, dropping from leaves and being suspended from the host on a silk

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strand permits easy spread by wind and convection currents; second, mats or tents of webbing over or around the mite colonies provides some degree of protection from natural enemies and treatments with pesticides. Although a general family characteristic, silk webbing is not produced by all spider mites; and some do more than others.

The typical developmental stages for spider mites include a round, usually flattened egg, a 6-legged "larvae," an 8-legged protonymph, an 8-legged deutonymph, and an 8-legged female and male adult. The generalized life cycle from egg hatch to adult can occur in as few as 4-6 days, with adult females laying several hundred eggs over a period of from 2-3 weeks. Many generations can occur during the appropriate part of the growing season, accounting for the rapid population buildup and enormous numbers of mites that are common on trees and shrubs.

With regard to practical control of mites, two critical characteristics of pest species are host plant preferences and seasonal occurrence. These two factors are given for the major pests in the discussion that follows, along with other specific characteristics and habits. The more important spider mites can be tentatively identified by the non-entomologist in knowing the host plant, the general color and size of the mite, the location of the mites on the plant, and the general period of activity during the season.

Understanding the feeding mechanism and general appearance of damage is helpful in understanding the nature of spider mite damage. Spider mites have a sharp pair of needle-like stylets that are attached internally to a plate that is moved by strong muscles. The stylets are thrust in and out to tear into the cells of host leaf tissue. Cell contents are drained by the mite when inserting its mouth into the injured cells. The feeding removes the chlorophyll and causes scattered pin-point chlorotic (yellow, tan, or white) flecks in the otherwise green foliage. The stipling is evident on the upper surface of leaves on most plants even when the feeding is primarily on the lower surface. The continued feeding of increasing numbers of mites frequently causes complete yellowing or bronzing, then browning and dying of the foliage. This is especially critical on evergreens that depend on foliage nutritionally for more than one growing season. Damage done to the foliage is not repaired by the plant, and frequently premature leaf drop results in a high percentage of defoliation. Unsightliness of injured foliage may persist for several seasons.

Spruce mite (Oligonychus ununguis)

The spruce mite attacks only conifers, primarily hemlock, spruce, arborvitae, and juniper, and to a lesser extent, fir and pine. It is less likely to attack chamaecyparis and certain other conifers. Mites very closely resembling spruce mite may be *O. milleri* when found on pine.

Adult spruce mites are about ½ mm in length and dark green or reddish green with tan legs. They occur on both the needles and the twigs, although they feed only on foliage. Eggs are reddish tan and nymphs tend to be greenish with tan legs. The spruce mite overwinters as eggs on the foliage and twigs of its hosts. It is favored most by *COOL* weather and tends to increase in numbers and in causing damage during early spring to early summer and again in the fall. It has been suggested, though not yet positively demonstrated, that eggs tend to go into summer dormancy as a protective device against hot, dry mid-summer conditions. The admonition that mites build up and cause damage in hot dry weather does *not* apply to this species nor the southern red mite and boxwood mite discussed below. Some of these mites are active during the summer, especially in cooler periods, but not usually in devastating infestations as in spring and fall. It is important to inspect plants regularly with a hand-lens, looking for eggs or mites and the first signs of feeding, to prevent population buildup and serious damage to conifers.

Southern red mite *(Oligonychus ilicis)*

This pest species attacks broad-leaved evergreens, especially Japanese hollies, pyracantha, and camellias, as well as other hollies, rhododendron, and other broad-leaved evergreens, especially in the deep South. It is not uncommon to find 100-200 or more mite eggs on a single *Ilex convexa* leaf in the spring where a severe infestation has been allowed to develop.

Although even such severe infestations seldom kill plants, they cause serious weakening, and at least two year's healthy growth is necessary to restore the aesthetic and economic value of the plants.

Much of what has been said about the spruce mite above applies to the southern red mite: it overwinters in the egg stage; it does not built up in severity during hot, dry weather; it is a *COOL* weather pest, developing devastating populations in the early spring and late fall; and it is suspected to "aestivate" (summer dormancy) in the egg stage during hot spells with low populations active in cooler summer periods.

Adults are about the same size as the spruce mite, but are blackish red and nymphs are light red, as are the eggs. Although predominantly on the underside of the leaves as eggs and active mites, they do occur on both surfaces. As with most mites, evidence of infestations that have disappeared includes white cast skins and empty egg shells in addition to the damage to the foliage. Dark reddish mites or red eggs and immatures on broadleaved evergreens can tentatively be identified as southern red mite without being an entomologist or mite specialist. Occasionally the two spotted mite (discussed later) may occur on some of the southern red mite hosts, but it can be distinguished by its coloration.

European red mite *(Panonychus ulmi)*

This spider mite is a serious pest of apple and other fruits, nuts, and their ornamental varieties, as well as mountain ash. It occasionally may attack elm, rose, and black locust. Adult mites are about ½ mm long and deep brick red with 4 rows of curved hairs on their backs arising from tan humps or tubercles. Nymphs and eggs are bright red. Each egg has a single, central stalk or hair, which is lacking on other similar mite eggs. The winter is passed in the egg stage. Hatching occurs in early spring as new growth begins. Feeding activity and plant injury occur throughout spring into early summer.

Honeylocust spider mite
(Eotetranychus multidigituli)

This spider mite is found only on honeylocust, especially its thornless horticultural varieties and cultivars. It is smaller as adults than the mite species already discussed, measuring about ⅓ mm in length. The mites and eggs are yellowish green and occur primarily on the undersides of the leaves. The winter is passed in the adult female stage under the bark on large branches and the trunk. Overwintering female forms are orange-red and generally inactive. Seasonal development is important. Mites begin to appear on foliage in June, increasing in numbers until severe injury to the foliage and defoliation occurs in July and early August. Eggs hatch in 5-7 days and the developmental period from egg hatch to adult takes only 4-11 days, accounting for very rapid buildup of populations. Control measures should be applied during June, not in the spring nor after major damage has been done in July and August.

Oak red mite *(Oligonychus bicolor)*

Another summer pest, this mite is found only on the upper leaf surfaces of oaks, chestnut, birch, and beech, primarily, and to some extent on hickory and elm. Adults are similar in size to southern red mite and dark red, while nymphs and eggs are reddish. Damage becomes severe by mid-July into August causing very noticeable grayish-tan appearance of the foliage. Trees seldom are seriously affected, but the damage is quite apparent even at a distance, particularly on red oaks.

Elm spider mites *(Eotetranychus* spp., *Oligonychus* spp. *Tetranychus* spp.)

At least 8 species of spider mites attack elm. The more damaging species begin activity in June, causing severe injury during July and August. Mite problems on elm have been much less prevalent since the use of DDT has ended. The use of carbaryl (Sevin) has an effect similar to DDT, causing increases in mite populations, so arborists should be watchful of potential mite buildup following application of that insecticide.

Linden mites *(Eotetranychus* and *Tetranychus* spp.)

At least 3 species of spider mites attack *Tilia* with the same seasonal patterns and habits as for

elm. For linden and elm, control measures should be applied in June to prevent serious damage in July and August. Also a miticide added to the first Japanese beetle spray is a good way to accomplish the objective.

Two-spotted mite *(Tetranychus urticae)*

The two-spotted mite is the proper common name for this particularly troublesome species, also called the greenhouse red spider mite or "red spider." Fortunately, it does not occur as generally on shade trees and shrubs as it does on flowers, foliage plants, corn and other field crops, vegetables, brambles, and other herbacious type plants. However, it is a serious pest of roses, flowering fruits, and a number of various shrubs, especially when planted out after propagation in the greenhouse. This mite has well over 250 host plants.

Adult mites are large, yellowish with two more or less predominant dark spots evident on the back. The spots are the result of accumulation of food material in the digestive tract, so they become more apparent as each nymphal instar matures and less following a molt. Eggs and immatures are lemon yellow and often live and feed beneath mats of silk webbing spun over the undersurfaces of the leaves.

The two-spotted mite occurs, reproduces, and causes damage throughout the entire growing season. The warmer the temperature the greater its feeding activity and reproductive rate. Thus the two-spotted mite can be expected to become especially destructive during hot, dry weather; but it also thrives during cooler periods of the season as well. This spider mite has been notorious in developing resistance to chemical pesticides. Fortunately resistant strains of other spider mites outdoors on trees and shrubs have not yet been demonstrated.

GALL, RUST, BLISTER, AND BUD MITES (Eriophyidae)

This family of mites includes many hundreds of species, most of which are highly host specific. The majority normally occur in populations low enough that they are not considered to be serious pests. Since they cause quite conspicuous galls, russeting and blistering of foliage, and bud blasting, people frequently become concerned about potential harm to the host plants. Because of their extremely small size, mites are often overlooked and seldom seen by most people even with a magnifier. Eriophyid mite feeding and the injection of saliva incites plants to react, so that the presence of these mites is usually noted by the galls, blisters, or russetting after it is too late to prevent the condition from developing.

Adult eriophyid mites, when fully developed, are from 1/6 to ¼ mm in length, often less than the diameter of a spider mite egg. They are more difficult to see even with a hand-lens. They are usually either worm-like or carrot-shaped, pearly white, yellowish, or orange, depending on the species and on the seasonal form. Some have summer forms that are worm-like and light colored, and winter forms that are carrot-shaped and orange in the same species. They usually overwinter as adult females under bark or other protected places on the host plant. There is seasonal variation in activity periods between species as with the spider mites. These mites have only two pairs of legs, very simple structure anatomically and a similar type of mouthpart compared to spider mites, though much smaller. Consequently, they do not produce the stipling associated with spider mites, but rather a russeting of the surface that may appear as a grayish cast or bronzing. They are especially characteristic in inciting tissue proliferation by the plant in the forms of widely varying types of galls and other unusual plant growths.

Maple gall mites *(Vasates* and *Aceria* spp.)

Maple gall mites comprise one of the most conspicuous and common problems resulting in very frequent inquiries as to the threat of damage to trees and shrubs, however, they are seldom seriously injurious to their hosts. Three types of galls are commonly found. Maple bladder galls are green or red wart-like growths that occur chiefly on the upper leaf surfaces of red and silver maple. Maple spindle galls are long, narrow growths projecting upward from the leaf and occur predominantly on sugar maple. Maple erineum galls are green or reddish patches on the undersurface of silver and red maples, and green or

yellowish patches on boxelder. Under a handlens the patches look like the magnified surface of a beaded-glass projection screen. Mites seldom are seen, since they live between the microscopic stalks of the growths on the leaf surface.

Overwintering females emerge and crawl from the bark onto new growth as foliage begins to leaf out in early spring. As each mite feeds on the undersides of the foliage, leaves develop a depression that grows into a gall around the mite. The gall develops on the upper leaf surface, retaining an opening on the underside. Within, the mite feeds and lays eggs that develop into a colony eventually of hundreds of mites. As they become mature, adult mites leave the gall and move to other newly developing leaves. Gall production tapers off and ceases as new growth begins to slow down in late spring. Growth produced in late spring and during the summer usually is without gall formations.

There are bladder, erineum, and spindle type galls on many other plants, but usually not as conspicuous as with maple gall mites. Neither are they seriously damaging to the hosts.

Hemlock rust mite *(Nalepela tsugifolia)*

This eriophyid mite is a serious pest of hemlock from New England into the Carolinas and Tennessee and the eastern U.S. generally. Oddly, it is a *COLD* weather pest, laying eggs and feeding actively when the daytime temperatures are in the upper 40's and 50's. It can be found in small numbers in late spring and during the summer, but usually is highly destructive in early spring and late fall. Often the injury and damage does not become evident until after the mites have completed development of large populations and become decimated. There can be as many as 100 or more mites on a single needle. Feeding results in a grayish cast of the foliage and considerable yellowing later that suggests soil or nutritional problems. The mites apparently overwinter as adult females under the bark. Severe infestations may be spotty from branch to branch on individual plants or from plant to plant in the nursery or landscape.

Privet rust mite *(Aculus ligustri)*

This is common on regal and California privet which are grown commonly, though they are not among the more valuable ornamentals. It is very similar to the hemlock rust mite in habits, seasonal development, and damage. It causes severe cupping of the leaves in addition to the grayish surface cast or russetting of the foliage.

Taxus bud mite *(Cecidophyopsis psilaspis)*

Fortunately the taxus bud-mite has not yet become well established in the U.S., but has been found on Long Island and can be a problem in the Netherlands. Adult females crawl between the bud scales to feed on new tissue inside the bud. As egglaying commences and large populations build up, internal rot develops. The decaying buds that are full of mites then have a blasted appearance externally. Buds with very light populations often grow but produce twisted and distorted needles.

Other bud and blister mites

The ash flower gall mite causes great proliferation of bud tissue on male ash trees that is extremely unsightly but generally not seriously injurious to the trees. The camellia bud mite can cause serious damage to camellia. A mite on juniper and another species on arborvitae cause swelling tips rather than natural growth. Blister mites are not as serious as prior to the development of the newer pesticides, but occasionally pear-leaf blister mite causes severe injury to noncommercial pear trees. Mite feeding causes a depression in the leaf and gradually mites inhabit a round blister, feeding and reproducing in an area not unlike a small leafmine.

LIST OF OTHER MITE SPECIES ON TREES AND SHRUBS

Spider Mites (Tetranychidae)
avocado brown mite, *Oligonychus punicae*
avocado red mite, *Oligonychus yothersi*
brown mite, *Bryobia rubrioculus*
carmine spider mite, *Tetranychus cinnabarinus*
citrus red mite, *Panonychus citri*
clover mite, *Bryobia praetiosa*
elm spider mite, *Eotetranychus matthyssei*
four-spotted mite, *Tetranychus canadensis*
garman spider mite, *Eutetranychus uncatus*
linden spider mite, *Eutetranychus spinosus*
maple spider mite, *Oligonychus aceris*

McDaniel spider mite, *Tetranychus mcdanieli*
Newcomer spider mite, *Oligonychus newcomeri*
pacific spider mite, *Tetranychus pacificus*
pine spider mite, *Oligonychus milleri*
platanus mite, *Ologonychus platani*
poplar spider mite, *Eutetranychus populi*
Schoene spider mite, *Tetranychus schoenei*
six-spotted mite, *Eutetranychus sexmaculatus*
willamette mite, *Eotetranychus willamettei*
willow spider mite, *Schizotetranychus schizopus*
yellow spider mite, *Eotetranychus carpini borealis*

Gall, rust, blister and bud mites (Eriophyidae)
apple rust mite, *Aculus schlectendali*
ash flower gall mite, *Aceria fraxinovorus*
azalea bud mite, *Aculus atlantazaleae*
beech erineum mite, *Aceria fagerinea*
camellia bud mite, *Aceria camelliae*
citrus bud mite, *Aceria sheldoni*
citrus rust mite, *Phyllocuptruta oleivora*
fig rust mite, *Aceria ficus*
filbert bud mite, *Phytoptus avalanae*
gardenia mite, *Eriophyes gardeniella*
hackberry witchesbroom mite, *Eriophyes* sp.
juniper bud mite, *Trisetacus quadrisetus*
linden rust mite, *Eriophyes litiae*
linden gall mite, *Phytoptus abnormis*
pearleaf blister mite, *Eriophyes pyri*
pear rust mite, *Epitrimerus pyri*
pecan leafroll mite, *ceria caryae*
pine bud mite, *Trisetacus pini*
tipdwarf mite, *Calepitermeris thujae*
walnut blister mite, *Acerila erinea*
willow gall mite, *Eriophyes salicicola*

False spider mite (Tenuipalpidae)
citrus flat mite, *Brevipalpus lewisi*
phoenix flat mite, *Brevipalpus phoenicis*
azalea flat mite, *Brevipalpus lilium*
privet mite *Brevipalpus obovatus*

DETECTING MITE INFESTATIONS

It is important to find mites before they have caused appreciable damage. Do not rely on detecting the problem by signs of severe damage; serious injury will already have occurred. Susceptible plants should be spot-checked regularly at appropriate times in the season for first signs of mites and early stipling caused by feeding. During the winter conifers and broad-leaved evergreens can be examined with a hand-lens for overwintering eggs. During the growing season, on susceptible plants, a white card or tray can be held beneath branchlets while they are sharply rapped or shaken. Mites can be seen much as a sprinkling of pepper might look, and distinguished from "dirt" if they crawl. A hand-lens is essential to determine if eggs or mites are present, alive, feeding, and reproducing, and if natural enemies may be present in numbers.

NATURAL ENEMIES OF MITES

There are no known insect parasites of mites. There are fungal and virus diseases of mites and a host of predators including other mites, ladybird beetles (especially *Stethorus* spp., a very small, black, roundish beetle about 1 mm long as an adult, and hairy and gray as a larva), thrips, small true bugs (order Hemiptera), and certain lacewings (order Neuroptera). Predators are generally quite abundant among mite populations, especially after major buildup and damage has occurred; they seldom prevent population buildup of and serious injury from mites. Thus it may be detrimental to treat plants with pesticides after most of the damage has been done. Chemicals are essential to prevent damage and generally are less detrimental to natural enemies if applied before mite populations increase to damaging proportions.

CHEMICAL CONTROL OF MITES

Various pesticides affect insects and mites to varying degrees, so it is important to characterize the effectiveness of the common chemicals used for spraying. The following is a generalization to provide overall perspective with regard to control of mites. As different insects may or may not be controlled effectively by certain pesticides, mites are variably susceptible also. Some insecticides kill insects but not mites, while others kill both. Yet, some insecticides that do not kill spider mites are effective against eriophyid mites. It should be apparent then why it is important to know the different kinds of mites. Miticides are generally effective against most mites but not insects.

The insecticide carbaryl (Sevin) not only is ineffective against spider mites, but its use often contributes to larger populations (as DDT did in the past) than if spraying were not done at all. Yet carbaryl suppresses or is effective against certain eriophyid mites. Thiodan (endosulfan) is an excellent insecticide for aphids, clear-wing moth borers, and numerous other insects. It is not effective against spider mites, but is excellent for

the taxus bud mite and the cyclamen mite (family Tarsonemidae). Methoxychlor, lindane, Dylox, Dursban, Baytex and Imidan are not effective against mites. Malathion, diazinon, and Orthene (acephate) as well as parathion and Guthion, suppress and reduce mite populations but are not adequate for controlling serious infestations. The insecticide Trithion and ethion are excellent miticides as well as insecticides, although limited in labeled uses for shade tree and shrub applications. Zectran had similar properties but is no longer available. Systemic insecticides including dimethoate, Systox, Metasystox-R, Temik, Furadan and DiSyston are effective miticides as well as insecticides where they can be used on trees, shrubs, and nursery stock according to label directions.

The most effective chemical control of mites is achieved with petroleum oil sprays (dormant and summer) where they can be used, and with miticides. Kelthane (dicofol) is the most widely used, broadly labeled, and commonly available miticide for trees, shrubs, and other ornamentals. There have been and are a number of other miticides that may or may not be available because 1) they are not locally or generally marketed in a particular region, or 2) they are not registered for use on enough, if any ornamental plants, or 3) they have been restricted or banned. Some other miticides include Tedion, chlorobenzilate, Galecron, Morestan, Omite, and some newer materials with as yet limited registered uses including Plictran and Zardex.

General Recommendations

For general shade tree, shrub, and landscape spraying, mite control is reduced to relatively simple recommendations. They may vary somewhat from state to state, and must conform to state and federal pesticide application and label registration laws. It is best to obtain and follow the control recommendations provided by the Cooperative Extension Service. The most critical factor is proper timing, which depends on the type of mite and its habits.

Except for resistant two-spotted mite, Kelthane (dicofol) is generally effective and readily available for most mite pests on plants in the landscape. If available and labeled for use on trees and shrubs, other miticides should be effective, but most are labeled primarily for fruit and vegetable crops, greenhouse crops, and flowers. The systemic insecticides dimethoate (Cygon and DeFend), oxydemeton methyl (Metasystox-R), and disulfoton (DiSyston) are effective miticides (acaricides) where they can be used on trees and shrubs.

Petroleum oils should be used more widely by arborists, especially for overwintering eggs with dormant oil sprays. Summer oils, or summer rates for oil are generally effective against mites. The newer oil concentrates are generally safer to plants and more toxic to pests than the older heavier, less refined oil sprays. Also they are more acceptable to the public than synthetic organic pesticide chemicals. However, Kelthane is of very low mammalian toxicity.

Sources of Information

There are very limited literature sources to detailed information on mites for the arborist or practitioner. Many states have individual information sheets on the most important pests and recommendation or pest management guides for their control. The book "Insects that Feed on Trees and Shrubs" by Johnson and Lyon illustrates many species in color, including numerous gall and rust mites. "The Gardener's Bug Book" by Westcott contains general information on a long list of mite pests. Otherwise, most literature is highly technical and prepared for acarologists and other specialists. The following list of mites occasionally encountered or destructive, or more regional in occurrence is provided for reference and as an indication of the diversity of plant-feeding mite species.

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