CEDAR APPLE RUST
(fungi)

Beginning with Cedar: Like other such fungi, CAR demands two hosts to complete its life cycle-cedar trees and apples-and in very precise and particular manners. First, cedar trees support its gruesome galls-roundish, reddish-brown, golfball-sized, and similarly dimpled. With warm spring rains, swollen, horn-like fingers descend from those dimples, dangling increasingly downward and outward with each successive shower-bright yellow-orange tentacles two inches long. During six to eight swelling/drying cycles, a single gall discharges two billion spores, its protuberances finally withering into exhausted, wrinkled threads.

On to the Apples: During the exact same time, nearby apple buds pop open, hopefully (from CAR's selfish viewpoint) providing perfect substrate for spore lodgment and growth. (The fungus prefers several hours of light rain, at fifty to seventy-five degrees Fahrenheit, falling on tender, succulent, four- to eight-day-old leaves or young fruits.) While the wind-blown spores may wander five miles from the "mother" cedar, most apple infections occur within a few hundred feet. There they morph into copper-colored pustules, each with a characteristic chlorotic halo-as many as three hundred spots on a given leaf. Within these putrescent pools, black pycniospores fuse to form hyphae growing toward the opposite leaf surface.

> An Etymological Aside: The word heteroecious, combining Greek words for "different" and "house," perfectly describes a rust's life cycle, alternating between two unrelated hosts. (Smuts, the other main type of plant infection, demonstrate an autoeaous or self-housed cycle-e.g., corn smut grows only on corn.) The suffix also helps form ecology, the study of the house where we live, and economics, household management.

Apples, Part Two: Our fungal strand, now massed on the lower leaf surface, erects quarter-inch-long structures ("aecia") directly below the original coppery spots. During the warm, moist weather of late summer-with a temperature of 75°F being optimal-these elongated sacs split into narrow strips and curl backward, releasing chains of airy brown aeciospores, which drift into the cracks and crevices of neighboring cedar twigs. It is in this form that CAR overwinters before growing (through the subsequent year) into the next generation of dimpled galls.

A Brief Review: Teliospores (on cedars), pycniospores (on apples), aeciospores (on apples), and back again. All manifestations of the same creature, but inhabiting different (and specific) parts of different (and specific) plants at different (and specific) times.

Breaking the Cycle: An orchard full of GAR proves quite "galling" to apple growers, defoliating and weakening trees and blemishing their fruits, rendering the latter unmarketable. So why not nip it in the bud-quite literally-by disrupting the heteroecious cycle? This calls for total eradication-every cedar within a spore's throw of apple orchards, plus wild apples and (likewise susceptible) native hawthorns. All must go! But what about that pretty pink crabapple in your mother's yard, or your own perfectly placed foundation planting of ornamental junipers? Just where does the Garden Gestapo stop? It is the veritable teliohorns of a dilemma....

While walking in the woods, though, there is no need to be frightened by an occasional gelatinous tendril. Unless, of course, you share a lot of apple DNA and your leaves are only four to eight days old.

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Dormant stage – Before May: Cedar apple rust gall. Removal at this stage prevents spores from denuding apple and crab apple trees.



Spore stage – Late April, Early May - Hard, brown galls on twigs become bright orange to red with jelly-like protrusions during warm, wet weather in April and May. At this stage, they release two billion spores.



Apple Tree Damage - Beginning around June: Damage to Apple and Ornamental Crab Apple Trees.
Spraying just when leaves and blossoms emerge will help. Remove damaged leaves.


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CEDAR-APPLE RUST

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SYMPTOMATOLOGY AND DISEASE CYCLE:

Cedar-apple rust, caused by the fungus *Gymnosporangium juniperi-virginianae*, is a distinctive disease that is indigenous and widespread throughout the Northeast in areas where apples, crabapples, and other related members of the Rose family grow in close proximity to *Juniperus* species, such as eastern red cedars and junipers. This fungus requires these two different hosts in order to complete its two-year life cycle.

The symptoms of this rust disease on red cedar and juniper are inconspicuous during the winter and appear as green to greenish-brown, kidney-shaped galls that vary in size from ¼-2" in diameter. During cool, rainy periods in the spring, distinctive bright orange, gelatinous telial horns (also called "spore horns") up to 4" long protrude from the surface of these galls. Tiny spores are released from these spore-horns and are carried by wind and driving rain to infect the alternate apple and crabapple hosts. As many as 7.5 million spores may be produced in a single gall and these spores have been known to be carried as far as 6 miles.

Symptoms of infection on the apple and crabapple hosts are also quite colorful. Lesions first appear in early June as greenish-yellow spots that increase in size and develop a characteristic bright yellowish-orange color and are visible on both the upper and lower leaf surfaces. Occasionally, symptoms develop on fruit and twigs. By midsummer, minute "spore cups" called aecia develop at the edge of the lesions on the lower leaf surface. The spores produced in these cups are released from midsummer into autumn and are carried by wind and rain back to the juniper and red cedar hosts where they complete the disease cycle. When these spores land, they germinate and stimulate the formation of galls, a process that takes from 19-22 months for completion.

DISEASE MANAGEMENT:

Cedar-apple rust is not considered a life-threatening disease to either type of host, so control measures are usually not necessary in most cases. However, if

significant defoliation and/or fruit loss is experienced on apple or crabapple hosts, control measures may be necessary. This disease can be effectively managed through the combined use of culture, sanitation, resistance, and fungicide sprays. Cultural methods involve removal of either host within ½-1 mile from the other although, in most cases, this is not feasible. Sanitation involves pruning and removing galls from the red cedar and juniper hosts during the dormant season. Once again, this is practical in limited situations where only a few trees are involved and only a few galls are present. Selection and planting of resistant cultivars or varieties is the most effective means of control since this effectively reduces or eliminates the occurrence of the disease. Examples of resistant junipers are *Juniperus chinensis* var. *sargentii*, *J. communis* cv. Aureospica, and *J. virginiana* cv. Tripartita. Resistant apple cultivars include Delicious, Empire, Jonamac, McIntosh, and Paulared. Resistant crabapples include Ellwangerina, Henry Kohankie, Ormiston Roy, and Red Baron.

The final strategy for disease control involves the proper selection, timing, and application of fungicide sprays. Thorough coverage of all parts of the tree is necessary and the sprays should be applied until runoff. The fungicide label will contain information on plant hosts and diseases, dosage rates, days-to-harvest intervals, and safety precautions. Among the fungicides registered for use in Connecticut are chlorothalonil, ferbam, mancozeb, triadimefon, triforine, and myclobutanil and should be applied as necessary. If harvesting fruit for consumption, please consult the fact sheet Disease Control for Home Apple Orchards. This guide contains information on fungicides registered for use on edible fruit. Use of fungicides to protect *Juniperus* species has yielded disappointing results due to the difficulty in determining the timing of the applications since this midsummer-through-fall infection period remains poorly understood. The only fungicide registered for use on junipers in the landscape is triadimefon.

Summary

Cedar-apple rust, caused by the fungus *Gymnosporangium juniperi-virginianae*, is an indigenous and widespread disease throughout the Northeast. It occurs in areas where apples and crabapples grow in close proximity to eastern red cedar and other species of juniper. The fungus requires these two different hosts in order to complete its life cycle. Symptoms are colorful on both types of hosts and can result in significant defoliation of crabapples and apples. Methods for minimizing the impact of this disease are discussed.

Apple Rust Disease

Apples and flowering crab apples are susceptible to several rust diseases, including cedar-apple rust, quince rust and hawthorn rust. Although incited by different species of fungi in the genus *Gymnosporangium*, they have in common the fact that they must spend part of their life cycle on various trees and shrubs of the *Juniperus* species, such as Eastern red cedar and common juniper.

All of the rust diseases can result in serious losses if environmental conditions are favorable for disease development. Since they are similar in appearance and life cycles, only cedar-apple rust will be discussed in detail.

Symptoms

Symptoms of cedar-apple rust are found on apples and *Juniper spp.* On apples, rust occurs on leaves and fruit and, less commonly, on bark tissue. Small yellow spots appear on the upper leaf surface usually within a week or two after bloom. The spots enlarge to one-quarter inch or more, and orange droplets appear in the center. Eventually, small black fruiting bodies are produced by the fungus in the spots. Later in the summer another type of fruiting structure containing spores of the fungus is produced on the underside of the leaf. These fruiting structures appear as a series of yellowish tubes called aecia. Some infected leaves may drop from the tree, but complete defoliation rarely occurs.

Fruit infections usually occur near the calyx end and are similar in color to the leaf infections but may become much larger--one-half inch or more in diameter. Black fruiting bodies and, occasionally, aecia develop on the fruit lesion.

On the small branches of *Juniperus spp.*, the fungus causes brown to reddish-brown swellings or galls one-quarter inch to two inches in diameter. These galls, commonly called cedar apples, take two years to mature. During rainy periods in May, orange gelatinous tendrils or spore horns, develop on the gall. These may extend from the gall as much as two inches. Each gall may have more than one hundred spore horns. During dry periods in May and early June, the spore horns lose their gelatinous consistency and appear inactive. However, they regain their appearance and function with the return of wet conditions. Sometime in late June the spore horns dry up and fall off. The gall persists on the tree, but does not function again. Severely infected trees may contain hundreds of individual galls.

Disease Cycle

Spores produced on spore horns on *Juniperus spp.* In the spring are very lightweight and easily carried by wind to apple leaves and fruit. Billions of spores can be produced on a single spore horn. Release of spores occurs during rainy periods. In Connecticut, spores are released until about the middle of June.

If a spore lands on a susceptible apple leaf and environmental conditions are favorable, infection can occur in as little as four hours. In one to three weeks, rust lesions appear on the apple leaves. Spores produced in aecia on apple leaves are wind disseminated back to leaves of *Juniperus spp.* The spores germinate, penetrate the leaves and cause galls. The galls produce spores the second spring after infection occurs, completing the two-year life cycle of the fungus.

Control

Removal of *Juniperus spp.* from the vicinity of apple orchards has been suggested as a means of control. Since spores produced on the cedars can be wind disseminated several miles, tree removal cannot be expected to give complete control. However, removing *Juniperus spp.* in the immediate vicinity of orchards can reduce the severity of disease.

Apple varieties differ greatly in their resistance to rust. Following is a list of varieties of apples grown in the variety test block at The University of Connecticut's Experimental Orchard located at Storrs, Connecticut and their relative resistance to rust.

Resistant or Immune	Intermediate	Susceptible
Carroll	Barry	Burgundy
Delicious	Earliblaze	Esopus Spitzenburg
Empire	Golden Delicious	English Russet
Holly	Magnolia Gold	Gala
Honeygold	Razor Russet	Idared
Jonamac	Spigold	Jonee
Jerseymac	Stark Bounty	Jono
Lobo	Winesap	July Red
Mollies Delicious		Jonagold
Macoun		Lura Red Monroe
McIntosh		Ozark Gold
Niagra		Prima
Priscilla		Quinte
Paulared		Rome
Raritan		Roanoke
Spencer		Red Baron
Scotia		Roxbury Russet

Stayman		Summerred
Sungold		Stark Jumbo
Senandoa		Vista Bella

Native flowering crab apples such as wild sweet crab, *Malus coronaria* and prairie crab, *M.ioensis* plus its cultivars, fringe petal crab, *M.ioensis* 'Fimbriata' and bechtel crab, *M. ionesis*'Plena' should be avoided if rust is serious in a particular location. Some cultivars of crab apple resistant to rust are: *Malus cv.*'Adams', *M. floribunda*, *M. hypehensis*, *M. cv.* 'Mary Potter', *M. sargentii*, *M. cv.* 'Snowdrift', *M. cv.*'Winter Gold'.

Rust resistant varieties of hawthorn such as Cockspur Hawthorn and Washington Hawthorn are available.

Several fungicides can be used to protect apples from cedar-apple rust. Triadimetone (Bayleton), ferbam (Carbamate), triforine (Funginex) and fenarimol (Rubigan) are all effective in controlling rust. The materials should be applied as sprays at seven to fourteen-day intervals starting at the pink stage of bud development up to the middle of June. Ferbam and fenarimol will also control apple scab. Check the fungicide label for information on rates and times of application. For more information on the control of apple pests send for *Spray Guide for Home Apple Orchards*available from the Bulletin Room, 1376 Storrs Road, The University of Connecticut, Storrs, CT 06269-4035.

On *Juniperus spp.* Chemical control of rust is seldom necessary. Hand picking of the galls before the spore horns emerge is a common practice. *Juniperus spp.* infected with cedar-apple rust will not die from the disease.

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