

PHYLLODY IN ROSES

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“Certain flaws are necessary for the whole. It would seem strange if old friends lacked certain quirks.”
— Goethe

Johann Wolfgang Von Goethe, the German poet best known for his work *Faust*, was also an astute botanical observer. In 1790, he described the strange appearance of rose flowers in which flower organs were replaced by leaf- and stem-like structures (Figure 1). These roses were an example of his theory that all the different plant organs borne on the stem are modifications of each other. In his words, “We may say with equal truth that a stamen is a diminished petal, or that a petal is an expanded stamen; that a sepal is a diminished stem-leaf in a more refined condition, or that a stem-leaf is a sepal in a state of expansion occasioned by crude juices.” In 1869, Maxwell T. Masters named the condition “phyllody” (fil-o-dee) in his book devoted to plant abnormalities. Two illustrations from Masters’ book are reproduced here that show roses in which the carpels (ovule-bearing structures) and sepals (bud leaves) are replaced by perfect leaves (Figures 2 and 3). For the most part, Goethe was correct in his theory; modern plant anatomy describes these organs as homologous.

Foundation Plant Services (FPS), a department in the College of Agricultural and Environmental Sciences at the University of California, Davis, maintains a virus-tested rose collection containing over 400 rose varieties (Golino 2002). The authors, FPS plant pathologists, have seen phyllody regularly in a number of rose varieties over the years, and taken a special interest in monitoring this condition since phyllody is sometimes caused by phytoplasmas, a type of plant disease. They have also had inquiries from rose nurseries and rose growers about phyllody: Is it a disease or not? If it is a disease, can it spread? How can we determine if roses showing symptoms of phyllody are diseased? This article will review the phenomenon of phyllody in roses and discuss strategies for evaluating plants showing symptoms.

Phyllody is a flower abnormality in which leaf-like structures replace flower organs. These often strange and startling flowers are formed when plant hormones are out of balance. Environmental conditions, water stress, insect damage, and infection by phytoplasmas and viruses can disrupt normal hormone production, inducing phyllody in many plant species. In roses, the most common cause is hot weather during the period



Figure 1, left: “Proliferous Rose...calyx and corolla are developed and arranged around the axis, but instead of the contracted receptacle with its stamens and styles in the center, the stem, variegated with green and red, again ascends; and on it are successively developed, unexpanded, dark-red petals of a smaller size, on some of which are visible traces of anthers. The stem goes on growing, *prickles* appear on it, the alternate petals continue to diminish in size, and change at last into stem-leaves, also variegated with red and green; a series of regular nodes is formed, and from their bud, small imperfect rose-buds burst forth.” (italics are Goethe’s own) Goethe, 1790.

Figure 2, right: “Rose, in which the axial portion of the flower was elongated and the carpels were more or less replaced by leaves.” Masters, 1869 p. 257.



of flower bud formation. If environmental factors are the cause, affected plants will usually show normal and abnormal flowers simultaneously, but otherwise look healthy. When the weather cools, the bush resumes producing normal flowers. Floribunda roses are more likely to exhibit phyllody, probably due to genetic susceptibility. In fact, one floribunda ancestor is *Rosa chinensis*, from which came the “Green rose”— a curious variety that has a stable mutation causing phyllody in all its flowers (Figure 4).

Experiments have shown that phyllody can also be induced in roses by applying cytokinins, the class of hormones responsible for shoot growth and cell division, and suppressed by subsequent application of gibberellins, the hormones responsible for cell enlargement and stem elongation. In the variety *Rosa x hybrida* ‘Motrea,’ phyllody was more common on buds and stems closer to the roots and on own-rooted plants than on those grafted to rootstock, presumably because the rootstock affected the amount and type of hormone received by the top growth (Mor and Zeislin 1992).

One cause of phyllody in many crop plants is disease caused by phytoplasmas. Apparently, phytoplasmas, which inhabit the phloem tissue of infected plants, can have profound effects on the hormone balances in their hosts—affecting the appearance of leaves, petals, and other organs. Phytoplasmas are prokaryotes, the same

group of microbes that includes bacterial plant pathogens, but they differ from bacteria because they lack a cell wall. Phytoplasmas are reported to cause over 200 distinct plant diseases. Some of these are diseases cause “virescence” or phyllody symptoms; other phytoplasma diseases cause yellows or decline symptoms. Some of the phytoplasma phyllody diseases have descriptive names such as apple proliferation, aster yellows, big bud of tomatoes, clover phyllody and various witches’ brooms. A phytoplasma of poinsettia causes “excess” branching in some poinsettia varieties that is considered desirable in commercial production (Lee 2000). Insects—most often leafhoppers—can spread these diseases, so the appearance of phyllody in the garden often raises concerns about possible disease spread.

Only a few cases of apparent phytoplasma infection in roses have been reported (McCoy et al. 1989; Szyndel 2003). Unfortunately, most of this work was conducted before molecular laboratory tests were developed which could detect phytoplasmas, so it has not been clearly established that the diseases were caused by phytoplasmas. Often, the symptoms include severe decline. An example is one report from India in which phyllody of roses was suspected to be caused by phytoplasma infection. In this case, phyllody was observed in a nursery in several *Rosa bourboniana* ‘Calciata’ bushes. Every flower in the affected bushes was completely transformed, and



Figure 3, left: “Proliferous Rose. Calyx leafy; petals normal, some reflexed; stamens and pistil absent; in their places a branch with leaves and flowers.” Masters, 1869 p.151.

Figure 4, above: The “Green rose” — *Rosa chinensis* ‘Viridiflora’ — a stable mutation in that shows phyllody in all its flowers. It was discovered in China about 1833. Illustration from Starosta and Cruse, 1998.

the bushes were severely stunted, had tip dieback, and thread-like leaves (Singh et al. 1997). These symptoms are very different than the symptoms associated with physiological phyllody in roses.

Rose rosette disease is also reported to cause phyllody of rose blossoms. Rose rosette is a disease transmitted by the eriophyid mite *Phyllocoptes fructiplilus*. Symptoms include witches' broom of the foliage, reddening of the foliage and phyllody. In multiflora roses, death usually results. In fact, multiflora roses are used as indexing plants to detect rose rosette. Garden roses may have less severe symptoms. Rose rosette is believed to be caused by a virus, since dsRNAs (a marker for plant viruses) are present in symptomatic plants, although the actual virus has not been found and characterized. Rose rosette is most easily distinguished from other causes of rose phyllody by the severe foliar symptoms and the witches' broom symptoms of shoots and stems.

In the cases of the reports cited above, disease symptoms were not limited to the blossoms. Foliage and growth were also abnormal.

In 2003, newly developed PCR (Polymerase Chain Reaction) testing techniques for phytoplasmas were used to screen rose varieties in the FPS collection that showed phyllody symptoms. PCR is a type of molecular laboratory test which involves the selective amplification of a small part of any unique genetic code by the use of special enzymes. In this case, the genetic code of phytoplasmas is targeted for amplification. This test will indicate if phytoplasmas are present in a rose plant; a major step forward in phytoplasma diagnosis because, until recently, only difficult biological tests and/or laborious electron microscopy could be used to determine if a plant was infected with phytoplasmas.

FPS pathologists tested 10 rose selections that have demonstrated phyllody symptoms: 'Centennial Star', 'Earth Song', 'Kordes Perfecta', 'Michelangelo', 'Perfume Delight', 'Pink Grootendorst', 'Rouge Royale', 'Toulouse Lautrec' and two seedlings. Despite repeated testing, no phytoplasmas were detected. In addition, these bushes appeared healthy and grew well. Flowers throughout most of the season were normal.



Figure 5. Phyllody may have a variety of appearances in roses: clockwise from upper left; 'Pink Grootendorst', 'Singin in the Rain', 'Pink Dreams', and 'Toulouse Lautrec.' No virus or phytoplasma diseases were detected in these plants when tested by the FPS laboratory.



It is fair to conclude that most cases of rose phyllody seem to be associated with a physiological phyllody which is not uncommon in garden roses. Phytoplasma infection of roses appears to be relatively rare; numerous attempts in the FPS laboratory to inoculate modern roses with phyllody-type phytoplasmas have failed (Golino, unpublished). Although reports exist of rose phyllody diseases which may be caused by phytoplasma, they are infrequent and the association with phytoplasma is poorly documented.

From the perspective of an individual rosarian, it is helpful to carefully examine a rose with phyllody. When rose phyllody is due to genetic and environmental factors, the abnormality is limited to the blossoms, and normal blossoms appear at other times in the season. Experience with the characteristics of individual varieties, the lack of any stunting or yellowing symptoms, and good growth overall are all indications that phytoplasma infection is unlikely. Gardeners who see a few leaflike petals in a blossom should not panic. It is most likely to be an individual flower responding to specific environmental conditions, not a serious disease.

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