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WITCHES'-BROOMS: STRESS SYMPTOM TO GENETICALLY MODIFIED ORGANISM

One of my pastimes while hiking in the hills or driving in the country is looking for witches'-brooms in trees, shrubs, and perennials. Witches'-broom is a general term that describes a dense proliferation of stems and foliage originating from a single point on a stem or branch. The stems often have a distorted growth pattern that makes the broom look like a bird's nest or dense shrub growing within the affected host. Witches'-brooms can be caused by the host's response to insects, mites, viruses, fungi, parasitic plants, and, in rare cases, spontaneous genetic mutations. This latter type is the source of new selections and of particular interest to the nursery industry.

The appearance of brooms and their frequency varies with the cause of the broom and the susceptibility of the host species. As an example, common hackberry (*Celtis occidentalis*), is attacked by an eriophyid mite that causes witches'-brooms on this tree in the eastern U.S., but much less frequently in the northern Plains. Buds become infested with mites causing the distorted growths. The tree typically survives, but is aesthetically damaged. Honeysuckle (*Lonicera*) species can produce high numbers of brooms in response to an aphid attack. It is theorized that brooms are caused by toxins or growth regulators in the aphid's saliva. For deciduous species, the damage is most evident after leaf fall. Treatment is to prune off the brooms and control the plant pest with a labeled pesticide to prevent future damage. Some species and cultivars are reported to be resistant, but anecdotal information is contradictory. Although blueleaf honeysuckle (*Lonicera korolkowii*) is reported to be susceptible to honeysuckle aphid, both the species and cultivar 'Freedom' are widely recommended in the western U.S. by nurseries and conservationists as substitutes for the highly susceptible Tatarian honeysuckle (*Lonicera tatarica*).

Disease can cause broom formation as well. Several types of powdery mildew (*Sphaerotheca*) cause witches'-brooms in oaks (*Quercus* species), hackberry, and ninebark (*Physocarpus*) species. In some cases it is unclear whether the disease causes the broom or if the disease is a secondary response to the dense, succulent growth of the broom. Other species susceptible to disease brooms include various cherry (*Prunus*) species, apricots, ponderosa pine (*Pinus ponderosa*), Rocky Mountain juniper (*Juniperus scopulorum*), and ash (*Fraxinus*) species. The most common source of witches'-brooms in the northern Plains are dwarf mistletoes, cholorphyllous seed plants that parasitize the stems of several coniferous species including lodgepole pine (*Pinus contorta*), limber pine (*Pinus flexilis*), Douglas-fir (*Pseudotsuga menziesii*), and ponderosa pine.

Of great interest to horticulturists, landscapers, and plant collectors are witches'-brooms caused by a spontaneous (for lack of any scientific evidence to the contrary) genetic mutation of a single bud. These types of brooms are technically "chimeras," or a portion of a plant with a genetic makeup different than the rest of the plant. Genetic brooms are most often found on conifers and the cause of the brooms has been the source of speculation since they were first identified. Many of the first genetic brooms were discovered in cemeteries, leading to the theory that the brooms were caused by a decomposition by-product. This theory was later discounted and the current thought is that cemeteries merely have a high number of mature ornamental conifers with adequate between-plant spacing to spot the brooms. A fair number of brooms are found along power lines, leading to the supposition that electromagnetic waves are

involved. Given that genetic brooms can be found almost anywhere, even wilderness areas, this theory seems unlikely. Whatever the cause, genetic brooms are excellent sources of potentially new selections of dwarf or semi-dwarf plants.

Genetic brooms typically produce only female flowers, which means that female broom flowers must be cross-pollinated with a standard or "normal" growing plant. The result is that seeds collected from the broom itself produce seedlings that are about 50 percent dwarf or semi-dwarf and 50 percent normal or standard growth. The interesting thing about the seedlings is the wide variety of "dwarfness" and "normality." Some seedlings may be so dwarf that they grow as if cultured as bonsai, often with little aesthetic appeal. The most ornamental selections have a more moderate rate of growth and appear as if they have been pruned or sheared to some degree. The standard seedlings demonstrate variability as well, with some fast growing seedlings maintaining a density above that normally associated with standard seedlings. If the broom itself has ornamental appeal, it may be rooted from stem cuttings or grafted onto rootstock.

The founding father of genetic broom identification and seedling selection is University of Connecticut Horticulture Professor (emeritus) Dr. Sidney Waxman. Dr. Waxman has been testing and selecting broom seedlings for over 30 years at UCONN Horticulture Research in Storrs, CT. He continues today evaluating and releasing ornamental conifers and shade trees at the 10-acre research center. Some 15 to 20 of his selections have been released to the commercial nursery market. Dr. Waxman has worked with eastern white pine (*Pinus strobus*), Scotch pine (*Pinus sylvestris*), jack pine (*Pinus banksiana*), red pine (*Pinus resinosa*), eastern hemlock (*Tsuga canadensis*), tamarack (*Larix laricina*), Norway spruce (*Picea abies*), Norway maple (*Acer platanoides*), and several others. From broom and other chance seedlings Dr. Waxman has released cultivars such as 'UConn', 'Blue Jay', 'Soft Touch', 'Green Shadow', 'Sea Urchin', 'Golden Candles', and 'Paul Waxman' white pine; 'Florence', 'Julianne', and 'Howard Waxman' eastern hemlock; 'Newport Beauty', 'Deborah Waxman', and 'Varied Directions' larch; and 'Sandcastle' and 'Thunderhead' red pine; to name a few.

So how do you tell the difference between an insect or disease-induced broom and a genetic one? Although there are no sure-fire methods in the field, there are a few guidelines that help separate the two types. The overwhelming majority of genetic brooms are found on conifers. A genetic broom is rare with perhaps 1 in 10,000 to 100,000 trees having a genetic broom. If there are many brooms on a tree or in an area, it indicates that they are not genetic. Of course, a genetic broom could be produced among a stand of disease brooms, but good luck finding it. Genetic brooms are typically healthy looking, and tend to have a fairly uniform and vigorous appearance from the ground. That being said, genetic brooms can also deteriorate over time, being shaded by the host or adjacent plants or attacked by insects or disease. Genetic brooms produce cones or fruit that are smaller than the fruit of the standard plant. Disease brooms, because they are under stress, do not tend to produce abundant healthy fruit. The only sure way to determine the type of broom is to collect seeds, grow the seedlings, and then evaluate for dwarfness.

So what's the conservation hitch? In all honesty, the historic use of dwarf seedling selection from brooms has been for ornamental applications. Dwarf seedlings do provide an opportunity to use woody perennials in small spaces, such as urban or residential locations, where a large specimen would outgrow the spot. Dwarf plants require less maintenance than standard plants where size or desired appearance mandate pruning. Because they are dwarf, they often require less water and fertility. An overlooked but potentially valuable use for broom seedlings may be as selections for living snowfences, windbreaks, and shelterbelts. "Normal" seedlings from brooms sometimes show an increased stem and foliage density that may lend itself well to these types of applications. Whatever the end use, cruising for brooms and growing the seedlings is an enjoyable endeavor for any hardcore horticulturist or gardener.

Please see the attached files for photos of genetic brooms on limber pine and broom seedlings.