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AUTUMN COLOR

THE eastern United States is fortunately located in one of the few regions of the world where brilliant autumn coloration of foliage prevails. There is only one small region in the southern hemisphere, and that in South America. In the northern hemisphere, there is a large region in eastern Asia, including central and northern Japan, and a small region in the southwestern part of Europe. In North America, the region characterized by brilliant autumn foliage extends from the Gulf of St. Lawrence to the southern United States and westward to the Great Plains, areas of extensive deciduous forests. Here the general climatic conditions are often just what is needed to produce that lovely phenomenon of nature—the autumn coloration of deciduous foliage.

In North America the most brilliant displays of autumn color are of course in southeastern Canada, northeastern United States and in certain other areas of high altitude. The further south one goes the less brilliant is the display of autumn color particularly in areas along the seacoast. In the higher altitudes of the south such as the Blue Ridge Mountains, the color is usually just as brilliant as in the northeastern United States.

In some years, the autumn color is much more pronounced than in others. There are always plants, the foliage of which turns yellow in the fall, but it is the brilliant reds and gorgeous scarlets which, in combination with the yellows, make autumn color of outstanding beauty. It is chiefly the reds and scarlets which are intensified by the right climatic conditions.

Leaves are green because they contain a complex material called chlorophyll. This is essential to the growth of all plants, except the saprophytes and a few parasites, for it is through the action of chlorophyll that the plant can manufacture the food that it requires from crude chemicals in the presence of light and heat. Chlorophyll is a highly complex chemical material, being continually manufactured in the leaf and at the same time being continually broken down. Ordinarily, the rate of its breakdown about equals the rate of its manufacture. In the fall, the rate of chlorophyll manufacture is gradually reduced, although the rate of its decomposition is maintained. The exact cause for this phenomenon is problematical, but the accumulation of waste products in the leaf may be the principal cause.

Why leaves are yellow

A certain stage is reached where there is little if any chlorophyll manufacture. Most of the chlorophyll already made eventually is destroyed. This is the reason why leaves are yellow, for the two yellow pigments usually present, carotin and xanthophyll, are continually masked by the chlorophyll. When most of the chlorophyll is destroyed, these pigments become apparent. These same coloring materials are present in large quantities in egg yolk, carrots, and in some yellow flowers.

When green plants are taken into dark places, such as a cellar, the leaves often turn yellow. Also, young shoots appearing for the first time under the dark conditions of the cellar are usually yellow. This is explained by the fact that chlorophyll is manufactured only in the presence of light. When light is absent, plants are unable to manufacture new chlorophyll and the yellow pigments become predominant as soon as all the previously manufactured chlorophyll has been destroyed.

The gradual cessation of chlorophyll manufacture and the final breakdown of all that previously made, completes the first stage in autumn coloration. This is the reason for certain plants becoming yellow. There are some plants, like most of the magnolias for instance, the leaves of which do not turn yellow, but change from green directly to brown. For some reason, the breakdown of the chlorophyll does not start soon enough or is not complete enough to result in the appearance of the yellow pigments. The yellow color does appear in the foliage of many other plants regardless of the weather conditions. There is an interesting high degree of individuality in certain species. Red maple, for instance, usually turns a good red in the fall, but certain individuals always color yellow. The same can be said of sugar maples and several other plants. This is a most interesting physiological problem worthy of further investigation.

Why leaves are red

The gorgeous beauty of most autumn color combinations results from the brilliant reds and scarlets, together with the yellows. The sassafras, some of the maples, oaks, sumacs, sourwood, tupelo, and other plants are particularly outstanding for their brilliant red autumn color. These plants are most interesting in that the brilliance of their color apparently varies from year to year. The red in their leaves is caused by a third pigment called anthocyanin, which results in some way from the accumulation of sugars and tannins in the leaf. In some of the maples valued for their sugar production, it is probably the sugars which cause this red color. The oaks, however, being rich in tannins probably owe their high autumn coloration to the presence of these.

There are two factors necessary in the production of red autumn color. The first is light. There must be warm, bright, sunny days in the fall, during which time the leaves naturally manufacture a great deal of sugar. Secondly, such days must be followed by cool nights, during which the temperature is below 45° F. Plant physiologists have shown definitely that, under such conditions, there is little or no translocation of sugars and other materials from the leaf to other parts of the plant. In other words, when cool nights occur, following warm, bright, sunny days, sugars and other materials are "trapped" in the leaves. The accumulation of these products results in the manufacture of the red anthocyanin.

The combination of these factors is well understood when one observes a certain tree that may be red only on that side exposed to the sun. Other leaves not directly in the sun's rays may be green or yellow. Leaves exposed to the sun have been able to manufacture more sugars, which when accumulated and "trapped" in the leaves by cold night temperatures may result in the red color. It is interesting to note that trees and shrubs growing in swamps and other low places are often among the first to color in the fall, simply because it is in such places that cold air first settles on still nights.

Dull autumn coloration

A warm, cloudy fall, sometimes with much rain, will restrict the formation of bright colored foliage. With insufficient sunlight, the sugar production is greatly reduced, and with warm nights, what little sugar has been manufactured in the leaves can be readily transported to the trunk and roots where it has no effect on the color of the foliage.

The leaves of many evergreens change color in autumn. Some of the junipers and arborvitaes are listed in the following groups. Some pines may turn yellow, but usually such color lasts only for a short time, the leaves quickly turning brown. This is particularly true of those evergreen leaves which are normally shed each year, and although the autumn color may not be conspicuous in many evergreen plants, nevertheless it is evident on close examination.

All leaves eventually turn brown. This is not an autumn color, but is merely the result of the death, and in some cases the decay of the plant tissue. Sometimes, the leaves turn brown while they still remain on the tree, as in the American beech and in some of the oaks. In other cases, like the sugar maple and the spicebush, the leaves drop from the plants while they are still brightly colored and turn brown afterwards.

Autumn color is then a physiological phenomenon which is very complex. There are plants the leaves of which will always turn yellow regardless of current climatic conditions, but many of the plants with red fall foliage will be striking in appearance only when warm, sunshiny days prevail, followed by nights with temperatures below 45° F. The sugar formation in the leaf, the amount of sunshine received by the plants, and the temperature of the air are three variable factors which to a large degree control autumn coloration.

The following lists include some of the ornamental woody plants which are valued for their autumn color and some which are not.

Shrubs and trees with good Yellow autumn color

Acer pennsylvanicum		Striped Maple
Acer saccharinum (A.dasycarpum)		Silver Maple
Acer saccharum	Yellow and red	Sugar Maple
Aesculus parviflora		Bottlebrush Buckeye
Benzoin aestivale		Spicebush
Betula species		Birch
Carya cordiformis (Hicoria cordiformis)		Bitternut
Carya ovata (Hicoria ovata)	Yellow brown	Shagbark Hickory
Celastrus species		Bittersweet
Cercis canadensis		American Redbud
Cladrastis lutea		Yellow-wood
Dirca palustris		Leatherwood
Fagus grandifolia (F.americana)	Golden brown	American Beech
Fraxinus americana	Yellow to red purple	White Ash
Ginkgo biloba		Maidenhair-tree
Hamamelis mollis		Chinese Witch-hazel
Hamamelis vernalis		Vernal Witch-hazel
Hamamelis virginiana		Common Witch-hazel
Hypericum species		St. Johnswort

Liriodendron Tulipifera		Tuliptree
Phellodendron amurense		Amur Corktree
Populus alba		White Poplar
Populus grandidentata	Orange yellow	Largetooth Aspen
Populus nigra italica		Lombardy Poplar
Populus tremuloides		Quaking Aspen
Quercus imbricaria	Yellow brown	Shingle Oak
Rosa rugosa	Yellow to orange	Rugosa Rose
Rosa virginiana (R. lucida)		Virginia Rose
Ulmus americana		American Elm
Zelkova serrata		Sawleaf Zelkova

Shrubs and trees with good Red autumn color

Acer ginnala		Amur Maple
Acer rubrum		Red Maple
Amelanchier species		Serviceberry
Aronia arbutifolia		Chokeberry
Berberis (many species)		Barberry
Cornus alba		Tatarian Dogwood
Cornus Amomum		Silky Dogwood
Cornus florida		Flowering Dogwood
Cotoneaster divaricata		Spreading Cotoneaster
Crataegus phaenopyrum (C. cordata)		Washington Thorn
Evonymus alata		Winged Euonymus
Evonymus atropurpureus		Wahoo
Evonymus obovata		Running Euonymus
Fothergilla major	Red and yellow	Large Fothergilla
Hamamelis japonica		Japanese Witch-hazel
Liquidambar Styraciflua		Sweetgum
Nyssa sylvatica		Tupelo
Oxydendrum arboreum		Sourwood
Parthenocissus quinquefolia (Ampelopsis quinquefolia)		Virginia Creeper
Parthenocissus tricuspidata (Ampelopsis tricuspidata)		Japanese Creeper
Quercus (many species)		Oak
Rhododendron Vaseyi (Azalea vaseyi)		Pinkshell Azalea
Rhus species		Sumac
Sassafras officinale (S. variifolium)		Common Sassafras
Spiraea prunifolia		Bridalwreath
Syringa oblata dilitata		
Vaccinium species		Blueberry
Viburnum dentatum	Glossy red	Arrowwood
Viburnum dilatatum	Russet Red	Linden Viburnum
Viburnum Lantana	Deep red	Wayfaring-tree

Viburnum Lentago	Purple red	Nannyberry
Viburnum prunifolium		Blackhaw
Viburnum tomentosum	Velvety, dull red	Doublefile Viburnum

Shrubs and trees with Bronze to Purple autumn color

Cornus racemosa (C. paniculata)	Reddish to purple	Gray Dogwood
Forsythia viridissima	Reddish purple	Greenstem Forsythia
Fraxinus americana	Red purple to yellow	White Ash
Gaultheria procumbens		Wintergreen
Juniperus horizontalis plumosa		
Juniperus virginiana		Red Cedar
Leucothoe Catesbaei		Drooping Leucothoe
Ligustrum obtusifolium Regelianum (L. ibota Regelianum)		Regel Privet
Mahonia repens		Creeping Hollygrape
Pachistima Canbyi		Canby Pachistima
Rubus hispidus	Reddish purple	Swamp Dewberry
Symphoricarpus Chenaultii		
Thuja occidentalis ericoides		
Thuja plicata		Giant Arborvitae
Viburnum acerifolium		Mapleleaf Viburnum

Shrubs and trees with no autumn color

Ailanthus altissima (A. glandulosa)	Ailanthus
Akebia quinata	Fiveleaf Akebia
Amygdalus Persica	Peach
Baccharis halimifolia	Groundselbush
Clematis (many species)	Clematis
Daphne Mezereum	February Daphne
Elaeagnus angustifolia	Russian-olive
Evonymus Bungeanus semipersistens	Midwinter Euonymus
Hibiscus syriacus	Shrub-althea
Ligustrum vulgare	European Privet
Lonicera fragrantissima	Winter Honeysuckle
Lonicera syringantha	Lilac Honeysuckle
Lonicera thibetica	Tibetan Honeysuckle
Lycium halimifolia	Common Matrimony-vine
Magnolia stellata	Star magnolia
Polygonum Auberti	China Fleecevine
Potentilla species	Cinquefoil
Robinia pseudoacacia	Common Locust
Salix blanda	Wisconsin Weeping Willow
Salix pentandra	Laurel Willow
Sophora japonica	Japan Pagoda-tree
Vitex Negundo	Negundo Chaste-tree

Wisterias and Forsythias

Visitors to the Arboretum next spring who enter by way of the Forest Hills gate will notice two important changes in the plantings.

1. The trellis on which the wisterias were growing at the south end of the shrub collection has been removed entirely. This trellis, erected about thirty years ago, has failed badly and in the interests of safety alone had to be removed. The shrub collection is situated in a low spot which repeated temperature records have shown to be about the coldest spot in the Arboretum. The winter temperatures are as much as twelve degrees lower than on surrounding higher ground. Many times, the wisteria flower buds have suffered injury during severe winters, when they might have come through satisfactorily had the plants been placed on higher ground in a more sheltered position.

The entire wisteria collection has been moved to nearby higher ground next the old Bussey dormitory, where the temperature on the coldest nights is from 8 to 12 degrees higher than in the shrub collection. In this new situation the soil is good, and ample protection is given from severe winter winds by a planting of pine trees. A rustic arbor has been erected specifically for these wisterias and eventually they can be observed to much better advantage than on the old trellis.

The removal of the old trellis allows for more circulation of air through the shrub collection. Even more important, it permits one to get a good view of the rows of shrubs in the shrub collection from the Forest Hills entrance, a view which was previously entirely blocked by the trellis. At the same time, this change places the wisterias under far better growing conditions, where it is expected that they will flower more profusely than they have during the past few years.

2. For several years the large planting of *Forsythia suspensa* at the southeastern end of the lilacs has failed to bloom properly. The plants being badly overgrown, it became impossible to give them sufficient renewal pruning. The planting has become a dense mass of undergrowth with nearly 50% of dead wood. The shrubs are to be cut back to ground level in order to permit young vigorous plants to sprout from the old stumps. This is the only logical way to renew such a densely overgrown mass. Specimen plants in the collection have not been touched, but the lovely bank of drooping forsythia in mass will not be conspicuous at flowering time for several years. After this, the increased flowering of this bank planting will justify our present drastic measures.

Both these changes have been necessary for some time and are now made in the interests of growing better plants.