Plant Hybrids. Many of our most valuable ornamental shrubs have been produced by natural or artificial hybridization. Among the best examples are the hybrid Lilacs and Rhododendrons. Most of the numerous varieties of Lilacs have been produced by hybridization and selection by Lemoine in France. These hybrids are for the most part confined to crosses within the species *Syringa vulgaris*. Hybrids cannot be made between the Villosae and Vulgares Lilacs and neither of these groups will cross with the Tree Lilacs. Within the Vulgares group hybrids are known between *S. vulgaris* and *S. oblata* and between *S. persica* and *S. vulgaris*. The latter hybrid, *S. chinensis*, first originated spontaneously but was subsequently produced by crossing the parental species. Rhododendron hybrids were produced for the most part by English plant breeders, although many crosses between species have occurred spontaneously in cultivation. The best known varieties of *Rhododendron* have been produced by crossing the American *R. catawbiense* with European or Asiatic species. Most of the species of Rhododendrons are interfertile and in some cases hybrids have been made between the true Rhododendrons and the Azaleas.

In the genus *Philadelphus* we have numerous examples of hybrids between species and it seems probable that all species in this genus are interfertile. Several hybrids are known between American and Asiatic species. These parental species must have been separated long before the Glacial Period, yet when they are brought together and crossed they produce perfectly fertile hybrids. Similar cases are known in the Rhododendrons and Apples.

The Arnold Arboretum offers unusual opportunities for the plant breeder because of the extensive collection of both American and Oriental species. Many of these have never before been brought together in the same collection so that they have never had an opportunity to cross naturally or to be combined by the plant breeder. In many cases it is impossible to cross distinct species but in certain genera or subfamilies crosses between species are easily obtained and in certain cases even generic hybrids are possible.
In the Pomoideae a number of generic hybrids are known to occur. Near the Forest Hills Gate is a large tree of *Sorbopyrus* which is a hybrid between *Sorbus* and *Pyrus*. Along the Willow path there is a small specimen of *Amelasorbus*, a natural hybrid between *Amelanchier* and *Sorbus*, which was discovered in Idaho by J. G. Jack. Another generic hybrid in this group of plants is *Sorbaronia*, a hybrid between *Sorbus* and *Aronia*. This hybrid is in the Shrub Collection. It has been found growing spontaneously in several regions in North America. Hybrids have also originated spontaneously between *Crataegus* and *Mespilus* and between *Pyrus* and *Cydonia*.

In this subfamily there are many ornamental trees and shrubs, as Apples, Pears, Flowering Quince, *Sorbus*, *Amelanchier*, *Cotoneaster*, and *Crataegus*. It is possible that additional hybrids can be made between some of these genera. This spring a number of crosses have been made between *Amelanchier* and *Pyrus*, the Japanese Quince and the Pear, between *Cotoneaster* and *Crataegus*. It is to be expected that many of these crosses will be unsuccessful, but if a few hybrids are obtained they should be of considerable interest and probably of some ornamental value.

The Lilacs offer some interesting opportunities for the plant breeder. Most of the earlier breeding work has been confined to the species *S. vulgaris*. There are, however, two other species which are very valuable, especially if they can be combined with the flowering habit of the common Lilac. *Syringa pubescens* is the most fragrant of all Lilacs but the flowers are not showy and the shrub is not graceful in its habit of growth. If this species could be combined with *S. vulgaris* it should give us an entirely new type of Lilac.

*Syringa pinnatifolia* is one of the most attractive Lilacs in its habit of growth but the flowers are borne in small clusters. This species combined with either *S. pubescens* or *S. vulgaris* should produce some interesting hybrids. The Persian Lilac is also a valuable species for the plant breeder although when crossed with *S. vulgaris* it produces a sterile hybrid so that the cross cannot be carried beyond the first generation. Many of these sterile hybrids are valuable, however, because they flower freely and although they set no seed they can be propagated by grafting or by cuttings.

The Technique of Crossing. The methods used in making crosses between species or varieties are dependent on the natural method of pollination. Plants are chiefly insect pollinated, wind pollinated, or self pollinated. Most plants with conspicuous flowers are insect pollinated while those with inconspicuous flowers are usually wind pollinated. Among the former are the Apples and related genera, while the wind pollinated plants include the Conifers, the Oaks, and most of the grasses. All grasses are not wind pollinated, contrary to the statement in botanical textbooks, and among the economic genera Wheat, Oats and Barley are all normally self pollinated.
Sorbopyrus auricularis var. bulbiformis
Photographed in the Arnold Arboretum, May 24, 1924,
by E. H. Wilson
In order to cross two species or varieties it is first necessary to prevent the normal pollination. With insect pollinated plants this is easily done by removing the anthers and petals just before the flower opens. The insects will not usually visit a flower which has the petals removed so that there is only a slight chance for pollination to occur. Apple flowers for instance are emasculated by removing the calyx together with the petals and anthers just before the flower opens leaving the stigmas exposed. Pollen from the male parent is then applied to the stigmas and the cross is made. It is advisable to leave a check branch on which the flowers have been emasculated and not pollinated to see if seeds set, due to insect or wind pollination. If the check branches do set fruit there is no assurance that the pollinated flowers will produce hybrids. This method of emasculation is known to be satisfactory with Apples and related genera, but it may not be applicable in all cases. If the stigmas are large and moist there is a chance that smaller insects will visit them and thus effect pollination. For such cases the flowers should be covered with a paper bag after emasculation and kept covered until the petals would normally drop.

In the case of wind pollinated flowers, it is necessary to cover the female flower before the stigma is receptive. For instance, in corn the ear is covered with a bag before the silks appear. When the silk is developed the bag is removed just long enough to dust on the pollen which has been collected and then covered again until all chance of wind pollination has passed. In the Pine the small cones are covered in the same way and when they are receptive the pollen from another species is applied and the cone again covered.

Lilacs are easily crossed by pulling off the corolla to which the anthers are attached and brushing the exposed stigma with a freshly opened anther from a mature flower of the other parental species or variety. Lilies are also easy to cross although many species seem to be intersterile. The anthers and petals are removed from the female parent just before the flower opens and the stigma covered with pollen from the male parent. In the case of the Lily it is probably best to cover the flower with a bag since small insects may carry the pollen to the stigma even when the petals are removed. A number of crosses have been made at the Arboretum using E. H. Wilson's Regal Lily as one of the parents, but since it takes from 3 to 6 years for a Lily to flower from seed it is too early to know the results of this work.

At best the breeding of new varieties of shrubs and trees is a long process. The hybrids cannot be expected to flower for several years at least and in some cases one must wait ten years or more to determine the flowering characters of the hybrid. Often a second generation is necessary in order to obtain the desired combination of characters and another five or ten years must elapse before the results are known. Nevertheless, it is a fascinating occupation and full of interesting surprises. One great advantage of working with trees and shrubs is that any hybrid obtained can be propagated by cuttings or by grafting even if it does not breed true from seeds or is sterile.

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