

THE ROLE OF PLANT PROPAGATION IN TAXONOMY AND CONSERVATION

C. RITCHIE BELL

University of North Carolina,
Chapel Hill, North Carolina 27514

Some knowledge of the fantastic diversity of plants and animals that we call "natural variation" has been of critical importance to mankind throughout the course of his history: which plants can be eaten and which must be avoided; which animals were prey and which were predator; which drugs will cure and which will kill. Because life often depended on some rudimentary degree of this quickly learned classification, taxonomy must be considered a very old profession.

With literally millions of species of plants and animals now known to science, one might think that all biological diversity would have been accounted for and that taxonomist would have long ago closed up shop. Quite the contrary. With new analytical tools, new advances in genetic correlation, and new pressures on the few undeveloped portions of the world that still contain many undescribed species, taxonomists still have work to do.

The title of my paper suggests the question I wish to address: "What role does plant propagation play in this work of plant classification and conservation?" As we attempt to answer the question, it must be kept in mind that, because of differences in personal and professional view-points concerning the concepts of taxonomic categories and the stability of plant names, both plant taxonomists and plant propagators themselves are often a major part of the problem as well as part of the solution.

If we attempt to summarize the total scope of biological diversity, we will find that despite the previously mentioned millions of species of plants and animals, we can go further: there are subspecies, varieties, forms, hybrids, cultivars, and, for many plants, named horticultural varieties. Indeed, it is quite likely that natural variation is so great that no two individual organisms on earth are really identical; each will vary in some way from all other organisms, even of the same species, because of some degree of difference in size, shape, color, physiology, chemical constituents or, if nothing else, in number of cells — or cell organelles. Such incredible variation is, of course, the result of certain genetic changes (i.e. mutation and recombination) and the constant interaction of the genetic system of an organism with the environment in which the organism exists.

Mutation, or genetic change at the codon or higher level, is the only source of actually new genetic material and, at least in terms of ultimate expression, is a rather rare event. Extensive historical studies in corn (*Zea*), fruit flies (*Drosophila*), and a few other experimental organisms provide a basis for an "average" mutation rate for a particular gene of one per 100,000 duplications. However, if we are to consider the total range of actual and potential variability that provides the array of forms of life, it might be instructive to look at mutation in a more appropriate context — namely in terms of the total production of male and female gametes rather than as a mere arithmetic ratio. Here the picture seems to change.

If we assume (again from experimental work) that an organism has 10,000 genes, and if all genes are assumed to have the same "average" mutation rate of 10^{-5} , one gamete in ten should have one mutant among its 10,000 genes. Thus if a single population of plants or animals produced only 1,000,000 gametes per breeding cycle, there could be 100,000 mutant gametes produced, or an equivalent of ten new mutant alleles for each of the 10,000 original genes! However, in reality, gamete production is much higher. A class study of a colorful, common fall weed of southeastern U.S., *Bidens aristosa* of the Asteraceae, provided some interesting average figures on gamete production in a single population of these plants covering only 40 square meters: there were 16 plants per square meter; there were an average of 25 heads, or inflorescences per plant with an average of 40 flowers each; there were five anthers in each flower and an average of 1500 pollen grains per anther. Thus if we multiply this out (40 square meters \times 16 plants per square meter \times 25 inflorescences \times 40 flowers \times 5 anthers \times 1500 pollen grains), we find that the 3,200,000 anthers produce 4,800,000,000 male gametes. With our previous figure of 10,000 genes per genome and a mutation rate of 10^{-5} , there would be nearly 500,000,000 mutant gametes produced in this one small population of *Bidens*! Fortunately no organism reaches its full reproductive potential; for one reason or another (including mutation) most of these gametes never function. However, there is a tremendous potential for variation through mutation in even small populations of organisms, and this potential is further enhanced by the genetic recombination that results from sexual reproduction, especially among outcrossing organisms.

Environmental factors — temperature, light, humidity, nutrients, competition, and predation — to list a few — interact at every stage of the organism's growth and development to further attenuate the actual degree of natural polymorphism that tends to keep both the taxonomist and the plant propaga-

tors in business — provided each new variant can be more or less consistently recognized, described, named, and catalogued or sold. And this brings us to the point concerning conservation.

Many of the biologically or aesthetically interesting plant variants, often called “freaks of nature” when they occur naturally but “the product of an extensive breeding program” when the result of a few lucky hybridizations and a bit of artificial selection, are, by the very nature of their creation, either rare or uncommon. Thus both their morphological differences and their rarity tend to give such plants added monetary value as well as scientific interest. Such added value or interest may, especially in the case of natural variants, lead to their extinction. On the other hand, if a mutant, hybrid, or other natural variant has sufficient cultural significance, fiscal value, or popular interest, these factors may, indeed, result in the conservation rather than the destruction of the variant plant.

For example, natural populations of a number of well known horticultural plants, such as *Ginkgo* and *Franklinia*, are unknown and the species survive only through the efforts of plant propagators. Many other species, such as *Rhododendron vaseyi* and *Shortia galacifolia*, to name two native to the southeastern U.S., occur naturally in only a few small, local endemic populations but are widespread and well known as horticultural plants and thus are in little danger of actual extinction.

Countless other variants have not been so fortunate. For example, *Lysimachia salicifolia*, first described by Ferdinand Mueller in his 1869 “Flora Australiensis”, has appeared again only in print — in 1905 in *Das Pflanzenreich* and more recently (1972) in “A Handbook to Plants of Victoria” by James Willis. This last reference contains the annotation “. . . only a single, inadequate Victorian collection is known, made at the mouth of the Snowy River by F. Mueller in Feb., 1855 — it has long since been presumed extinct in that locality.” The question, of course, is: was this truly just a single “freak of nature” such as a hybrid or a mutant, or a rare but real “taxonomic entity”, or perhaps just an overstretched figment of a fertile taxonomic imagination? If the plant had been propagated (which of course was neither practical nor possible at that stage of floristic work in Australia) it is possible that we might some day learn the answer. Now we can only guess.

By way of illustrating the role of plant propagation on a somewhat more happy taxonomic scenario, I would like to follow the taxonomic and horticultural history of a few plants in the interesting genus *Sarracenia*, a small group of 8 to 10 species of herbaceous, rhizomatic, perennial, insectivorous (or

“carnivorous”) plants native to the moist savannas of the southeastern United States. As with all carnivorous plants, these have had periodic attention from the public press and are of continuing commercial value around the world.

The hollow, often water-filled leaves of these plants were noted by the earliest botanical explorers and the first accounts of them reached Europe in 1586 with Bannister's report on Carolina plants. The first actual specimens of these plants to reach Europe seem to have been sent from Canada by Dr. Sarazin, for whom the genus is named, about 1650. A century later Mark Catesby included a plate of *Sarracenia purpurea* in his “natural History of Carolina, Florida, and the Bahamas”. This drawing, cited by Linnaeus in his 1753 description of the genus, has been designated as the lectotype of the species. So let us start our review with *Sarracenia purpurea*.

At one time *Sarracenia purpurea* occurred over much of eastern North America and is the most widespread of the species with considerable genetic and phenotypic variability. Flower color, for example, may range from very dark maroon for plants in full sun to very pale pink (with white style discs!) for plants in deep shade. If plants of either of these color extremes are transplanted to more moderate light, the flower color becomes, in subsequent years, more uniform and characteristic. Anthocyanin-free mutants of *S. purpurea*, with clear yellow flowers and no trace of red in the leaf veins, are known in Nova Scotia, near the northeast limit of the plant's range, and also in Michigan, some 1,000 miles inland near the northwestern edge of the range. There is, of course, no modification of color intensity in these plants under changed light conditions. Despite this range of color variation, *S. purpurea* has a number of distinctive qualitative features, especially in the leaves: an erect, wide, hood with stiff, downward pointing hairs; an exposed orifice; red veins and nectar area but no white spots or other markings and a short, fat “pitcher”.

Sarracenia flava, the second species described by Linnaeus, has stronger scented flowers with rich yellow petals, tall, erect, evenly tapered leaves (often of considerable size and digestive capacity!), with a glabrous, somewhat horizontal hood, partially covering the leaf orifice. *Sarracenia flava* is found only in the southeastern U.S. and color variation in the leaves, which is obviously genetic as shown by the different clones in this population, has no effect on flower color — no maroon flowered plants of *S. flava* have ever been reported.

Sarracenia catesbaei, was described as a new species by Stephen Elliott in 1824 in his “Sketch of the Botany of South Carolina and Georgia”, on the basis of some plants collected in

South Carolina by a Dr. MacBride. Subsequently the plant's identity was thoroughly confused: in Eaton's Manual of Botany (1836) the plant is considered a species, *S. catesbaei*; Croom (1848) considered it "hardly a variety of *S. flava*"; Decaisne (1851) named it under *S. flava*; later the name *S. flava* subsp. *catesbaei* was used by Mohr (1897) to refer to some plants growing along Little River in northeastern Alabama; Mohr (1901) soon raised these plants to specific rank and, thinking them to be distinct from *S. flava* and similar to those described by Elliott, called them *S. catesbaei*; Harper (1903) incorrectly applied the name *S. catesbaei* to some hybrids between *S. leucophylla* and *S. flava*; in an article on the history of *S. catesbaei*, Macfarlane (1904) considers the name to apply to the atypical *S. flava* growing around Mobile, Alabama, plants which today are recognized as constituting the species, *S. alata*. What was the problem? No other name in the genus has had such a varied history as *S. catesbaei*. The answer came from the work of the English plant propagators and hybridizers: *S. × catesbaei* is a natural hybrid. When MacFarlane (1908) monographed the genus *Sarracenia* for Das Pflanzenreich, he recognized the hybrid nature of *S. × catesbaei* and described the Mobile plants as a new species — *S. sledgei* (now *S. alata*). Mohr's plants from along Little River were placed under *S. flava* by MacFarlane (1908), and were not recognized and properly described as a distinct species until 1933, when they were described as *S. oreophila* by Wherry.

The first artificial *Sarracenia* hybrid to flower was exhibited and described in 1874 by Dr. David Moore of the Glasnevin Botanic Garden, Dublin. Although 4 to 7 years are required to raise a *Sarracenia* hybrid to flowering size, another artificial hybrid, *S. flava* × *S. purpurea*, was reported within a week. Hence, horticultural interest in these plants must have started around 1870. This interest increased until about 1886, when these plants lost general popularity as suddenly as they had gained it. The taxonomic and cultural information from this brief era of horticultural interest has, however, remained of biological and taxonomic importance to this day.

The morphology of *Sarracenia* flowers is equally as interesting as that of the leaves. The five stigmas are borne on the inner (recurved) surface of the expanded, flattened style disc which catches the pollen shed from the numerous anthers. Ants and other insects spread the pollen over the stigmas. The plants are self fertile and also hybridize easily. With the known parentage and careful descriptive work, often with illustrations, of the 19th century hybridizers and the fact that, in most instances, the hybrids are nicely intermediate between the parents, the likely parentage of most natural hybrids, and

even backcrosses or 3-way hybrids, can be ascertained on the basis of known qualitative and quantitative characters of the species, as illustrated in the following five natural hybrids:

S. rubra × *S. alata* = *S.* × *ahlesii*

S. minor × *S. psittacina* = *S.* × *formosa*

S. minor × *S. purpurea* = *S.* × *swaniana*

S. minor × *S. rubra* = *S.* × *rehderi*

S. leucophylla × *S. psittacina* = *S.* × *wrigleyana*

A beautiful color variant, an anthocyanin-free mutant of *Sarracenia rubra*, the sweet (fragrant) pitcher plant, is the most recent discovery of scientific and commercial importance in the genus. A few of these yellow-flowered plants were discovered in a bog in the mountains of western North Carolina about 10 years ago and were nearly wiped out by "collectors" within a year. From a single capsule we grew out 57 all yellow plants (which can easily be detected in the seedling stage). These plants are all now mature and blooming and providing more seed each year for further propagation. In time, we hope to have enough plants to offer for sale in the trade. At that time plants will also be available (as is now also the plan for the very rare *S. oreophila* also being grown from seed at the North Carolina Botanical Garden) for transplanting back into some of the more protected native habitats and the important role of plant propagation in taxonomy and conservation will have again been realized. Pitcher plants may never again be so common as to be collected by the van load, but neither will they become extinct.