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Progress of Plant Breeding in the United States.

BY

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Division of Vegetable Physiology and Pathology.

Reprint from Yearbook of Department of Agriculture for 1899.
CONTENTS.

Introduction .............................................................................................................. 465
Early agricultural and horticultural conditions ...................................................... 466
Early methods of plant breeding ............................................................................. 468
Evolution of methods of plant breeding during the nineteenth century .............. 470
Improvements effected during the nineteenth century ......................................... 475
  Improvement in grapes ......................................................................................... 475
  Improvement in pears ......................................................................................... 477
  Improvement in apples ....................................................................................... 478
  Improvement in plums ....................................................................................... 479
  Improvement in raspberries .............................................................................. 480
  Improvement in blackberries ............................................................................ 481
  Improvement in strawberries .......................................................................... 482
  Improvement in gooseberries .......................................................................... 483
  Improvement in vegetables .............................................................................. 483
  Improvement in cereals ..................................................................................... 486
  Improvement in flowers and ornamental plants ................................................. 488
  Improvement in nuts ......................................................................................... 489
  Improvement in cotton ..................................................................................... 490

ILLUSTRATIONS.

PLATES.

Plate XXXVI. Two prominent early plant breeders ........................................... 468
  XXXVII. Improvement of the native gooseberry .............................................. 482
  XXXVIII. Fig. 1.—Improvement of corn by selection. Fig. 2.—Variation in seedling pecans. 486

TEXT FIGURES.

Fig. 22. Plums showing difference between hybrid and parent ............................ 479
  23. Hovey's Seedling strawberry .................................................................... 482
PROGRESS OF PLANT BREEDING IN THE UNITED STATES.

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INTRODUCTION.

At the beginning of the nineteenth century a few of the most advanced scientific horticulturists were commencing to recognize that plants, like animals, are capable of being improved by breeding. During the century the knowledge of the factors involved in plant breeding gradually increased and became disseminated among practical American growers. As a natural consequence of this there came to be a better understanding of the methods of plant breeding and a greater appreciation of the necessity of securing varieties adapted to local conditions, and therefore improved sorts of American origin have been gradually but surely supplanting foreign varieties.

While at the beginning of this period almost all of our cultivated fruits, cereals, vegetables, and flowers were of foreign origin, an inspection of the present trade lists shows a marked increase of native sorts and a corresponding decrease of foreign sorts. In the case of flowers, for the production of which artificial conditions largely are maintained, home-produced sorts vie in numbers with those from abroad. In cereals and vegetables a majority of the most extensively grown sorts are of American origin, and in fruits, upon which probably the most attention and skill have been brought to bear and the greatest stimulus given by well-organized societies, the native sorts have almost entirely taken the place of the foreign ones. "In the beginning of the colonization of this country," writes Bailey, "all the varieties of apples were of European origin. But in 1817, over 60 per cent of the apples recommended for cultivation here were of American origin, that is, American-grown seedlings from the original stock. At the present time [1895], fully 90 per cent of the popular apples of the Atlantic States are American productions."

The same increase of American sorts has taken place in the case of pears. As early as 1853 Hovey wrote: "It is certainly somewhat remarkable, as it is surprising, that, in the course of twenty-four years, a larger number of really fine pears have been brought to notice, of American origin, than have been introduced from Europe in the same time, or we think we might safely add, in the last fifty years." While in plums the American seedlings of the European and Japanese
species rival the sorts of foreign production, the improved sorts of our native species and hybrids of these with the Japan and apricot plums are rapidly increasing and will probably soon predominate in this industry. In the cultivation of grapes, raspberries, blackberries, etc., little advance was made until our native species were taken up and improved. All of these have been profoundly modified and improved as the result of merely half a century of cultivation and breeding.

It is interesting to note that the present century has witnessed the first introduction and wonderful amelioration of some of our now most important plants. A striking instance of such a plant is the tomato, which is said to have been first brought from Santo Domingo to Philadelphia in 1798, but was not sold in the markets of that city, according to Manning, until 1829, and did not come into general use in the North until some years later. Tomatoes were introduced into Salem, Mass., by an Italian painter, Michelo Corne, in 1802; but he was said to have had difficulty in persuading the people to eat them. They were, however, used as an article of food in New Orleans in 1812. The wonderful amelioration of the tomato has thus taken place wholly within the memory of men now living, and it is not an uncommon thing to find aged people, particularly among the pioneers of the West, who remember when the tomato was cultivated as an ornamental plant, but not thought to be valuable for food. The tomato is therefore an excellent illustration of what a century of plant breeding may accomplish.

The flowers now so extensively grown were hardly known a century ago, when different varieties were just beginning to appear. The mod- est chrysanthemum or the carnation of that day would hardly create a sensation in our modern flower markets. The immense cut-flower trade and the hosts of elegant varieties adapted thereto are the results of less than a century of plant breeding. The greenhouse has exerted a marked influence on the plants which are thus grown, as special varieties are demanded, and the skillful cultivator breeds and selects till he secures what is desired. In all forcing-house industries special varieties adapted to this sort of culture have sprung up. The changes which have already been wrought are the wonder of naturalists and laymen alike, but the end has not yet been reached. Everything indicates increased activity in the near future. Recent developments, obtained by a few independent experimenters, have forcibly called attention to the great improvements which skill and patience may achieve in this field, and a renewed interest in such matters is very evident throughout the country.

EARLY AGRICULTURAL AND HORTICULTURAL CONDITIONS.

In the early settlement of America agriculture was limited mainly to the cultivation of such plants as were known to the settlers in their
Old World homes. Each expedition brought seeds and plants to use in starting agricultural industries, and subsequent importations of desirable varieties continued to be made; hence, the attention of the settlers was largely given to testing these experimentally to determine their usefulness. The different conditions obtaining in America from those found in Europe, from which latter place most of the introduced sorts came, rendered the outcome of the early attempts very uncertain. No exact record of the agricultural development during this period exists, but it is probable that the early introduced varieties of the various annual crops (cereals, vegetables, etc.) went through a gradual evolution and adaptation to conditions by seed selection from those plants and strains found to do the best. This selection, which the settlers almost certainly exercised, probably did not have any definite improvement or change in view other than to secure the best and most vigorous seeds. Some of our now most important agricultural crops, like corn and tobacco, are native American plants, and their main improvement consequently dates from the discovery of America. In some places, however, the Indians had developed a comparatively high state of agriculture, and many sorts of such native cultivated plants were obtained from them, as, for example, the Golden Sioux, King Philip, and Tuscarora races of field corn. An early sweet corn is also recorded as having been obtained from the Indians. According to one account it was found and introduced into Connecticut by an officer in General Sullivan’s expedition against the Indians in the Genesee country in 1779. According to another account it was introduced into Massachusetts by Capt. Richard Bagnol, of Plymouth, who obtained it from the country of the Susquehanna on his return from the Sullivan expedition. The Six Nations, against which the Sullivan expedition was sent, had made considerable progress in agriculture, and are known to have cultivated large fields of corn. Besides this, they are said to have had "gardens of beans, peas, turnips, cabbages, melons, carrots, parsnips, and potatoes."

The earliest attempts at fruit growing in America were mostly failures. The varieties grown in early days were nearly all of European origin. The recorded history of American horticulture may be said not to have begun until the publication of Bernard M’Mahon’s American Gardener’s Calendar in 1806. At this comparatively late date native varieties had already become prominent, about 66 per cent of the 59 varieties of apples catalogued being of American origin. Even at this time, however, very great efforts were still being made to extend the range of cultivated products by introductions, the only very definite method by which the securing of new sorts was attempted. It was a costly experiment, however, and to a great extent disappointing. William Kenrick, in a letter to General Dearborn (quoted from Robert Manning), says: "From among 150 varieties imported into Boston by Eben Preble, about 1805, the only
additions to the list of desirable kinds were two cherries—the Black Tartarian and White Tartarian, and a single pear."

If we had to-day only the apples and pears known at the beginning of the century, the present extensive apple culture of the prairie States and the Northwest and the pear culture of the South would be wholly impossible. American varieties, the result both of chance discoveries and of the most careful and complex methods of plant breeding, have almost entirely supplanted the introduced varieties, and are destined to become even more important. To-day we look upon plant introduction as being to a large extent a means to an end. Russian apples are being extensively introduced, not wholly with the idea that they may become important commercial sorts themselves, but that select seedlings from them and hybrids between them and native varieties may be obtained, and through these the desired hardy, cold-resistant sorts of good quality.

In the culture of strawberries, raspberries, gooseberries, grapes, etc., no material progress was made until the improvement of the native species was begun. All these fruits went through an initial stage of depending upon foreign varieties, and following this an era of improvement, during which, by careful breeding of the native species and infusion into them of the improved European blood by hybridization, strains better adapted to American conditions were obtained. This change from an almost total reliance upon introduced varieties to a marked supremacy of sorts originated here has taken place almost wholly within the past century.

EARLY METHODS OF PLANT BREEDING.

The early settlers probably practiced crude selection in growing their plants, as anyone, whatever his degree of intelligence, will unconsciously do. It is this unconscious selection of individual plants through centuries that has led to the important changes which have taken place in our principal cultivated plants. So marked has been this amelioration that in very many instances the wild forms can not now be recognized and are unknown, the most careful study of modern scientists having failed to reveal the original types.

The necessity of having varieties adapted to existing conditions was early understood, as was also the necessity of selecting the best seed. Manning, in the History of the Massachusetts Horticultural Society, says: "And in 1621 the governor requested Massasoit to exchange some of their corn, for seed, with ours, that we might judge which best agreed with the soil where we lived. The natives were acquainted with the advantage of selecting the finest ears of corn for seed, and taught the settlers to do the same. They possessed varieties adapted to the warmer or colder parts of the country."

We are inclined to think of plant breeding as based on old and well-established laws. The fact is, however, that the fundamental
TWO PROMINENT EARLY PLANT BREEDERS.

THOMAS ANDREW KNIGHT.

EPHRAIM BULL
THE ORIGINATOR OF THE CONCORD GRAPE
ADAPTED FROM LADIES HOME JOURNAL.
principles of intelligent plant breeding were not made known until
the latter part of the eighteenth century. The sexuality of plants
was not established until proved experimentally by Camerarius in
1691, and the first hybrid of which we have any record was not made
until 1719, when Thomas Fairchild, an English gardener, crossed the
carnation with the sweet william.

Our first exact knowledge of hybrids dates from about 1761, when
Koelreuter began publishing the results of his observations. His
work was entirely scientific, however, and had but little bearing on
practical plant breeding, though it served to pave the way for the
valuable work, soon to follow, of Thomas Andrew Knight (Pl. XXXVI),
the eminent English plant physiologist. The systematic breeding of
plants may be said to have begun with the work of Knight and Van
Mons about the beginning of the nineteenth century. Knight was the
first to show the practical value of crossing and hybridizing in the
production of plant varieties. In 1806 Knight said: "New varieties
of every species of fruit will generally be better obtained by intro-
ducing the farina of one variety of fruit into the blossoms of another,
than by propagating any from a single kind."

Another important idea emphasized by Knight, and now quite gen-
erally accepted, is that one of the principal factors causing or inducing
variation in plants is an increase of food supply or a modification
thereof.

In one sense Knight may be recognized as the father of plant breed-
ing, no other experimenter having contributed so much toward the
development of the present system. Of almost equal importance,
however, was the work of a contemporaneous Belgian horticulturist,
Jean Baptiste Van Mons, who emphasized mainly the principle of
selection. His theories were published in various papers, but mostly
in his Arbres Fruitières in 1835. His method of obtaining new varie-
ties of fruit was to gather seeds from young trees in a state of varia-
tion, taking the fruits before they were fully ripe and allowing them
to rot, with the idea that this would tend to "subdue or enfeeble"
the tree, a factor which he thought to be of primary importance.
These seedlings were then grown in a seed bed until they were large
enough to enable him to judge of their character. He then selected
the promising ones and planted them in nursery form a few feet apart,
where they could be fruited on their own roots. When these selected
seedlings fruited, seeds were taken from the first fruits of the most
promising and sown, the same process of selection being exercised in
this second generation, and so on through several or many genera-
tions of selection till success was attained. The whole process is
expressed in his own words as follows: "To sow, to re-sow, to sow
again, to sow perpetually, in short to do nothing but sow, is the prac-
tice to be pursued, and which can not be departed from; and in short
this is the whole secret of the art I have employed."
As to the theory of selection, time has justified Van Mons's conclusions, with some modifications, but some of the ideas he advanced have been abandoned. He claimed that the older varieties of good fruit generally yield inferior seedling sorts, while new inferior varieties reproduced uninterruptedly for several generations would certainly yield good fruit. In these claims the results of recent years have shown him to have been somewhat in error. The general theory now advanced and used is to select seed for planting from the best fruits of the best tree of the best variety.

The importance of selection in improving varieties was well recognized before the publication of Van Mons's great work above referred to, and while the main credit of establishing the principle of selection is due to Van Mons, yet other independent workers accomplished nearly as important results. Bailey, in his Survival of the Unlike, called attention to the work done by Joseph Cooper, of New Jersey, in the closing years of the last century. Cooper's observations, recorded in a letter written in 1799 and published in the first volume of the Memoirs of the Philadelphia Society for Promoting Agriculture, show that he thoroughly understood the action of selection in producing changes in varieties. As an illustration, he says: "A striking instance of plants being naturalized happened by Colonel Matlack sending some watermelon seed from Georgia, which, he informed me by letter, were of superior quality. Knowing that seed from vegetables which had grown in more southern climates, required a longer summer than what grew here, I gave them the most favorable situation, and used glasses to bring them forward, yet very few ripened to perfection; but finding them to be as excellent in quality as described, I saved seed from those first ripe; and by continuing that practice four or five years, they became as early watermelons as I ever had."

It is probable that many other advanced horticulturists of that period understood and used selection in an intelligent manner. The directions given in 1822 by James Thatcher, in his American Orchardist, for the selection of seeds in attempting to produce improved sorts, would be regarded to-day as better than the recommendations given by Van Mons. "The seeds for planting," Thatcher wrote, "should always be selected from the most highly cultivated fruit, and the fairest and ripest specimen of such variety." Thatcher also described Knight's method of forcing seedlings into fruit by grafting them, and the use of hybridization in the production of varieties. It will thus be seen that even at this early date (1822) the fundamental principles of plant breeding had apparently become the common property of American agriculturists and horticulturists.

**EQUATION OF METHODS OF PLANT BREEDING DURING THE NINETEENTH CENTURY.**

It has been seen that the fundamental laws of plant breeding were fairly well understood at the beginning of the century and had come
to be expounded in horticultural text-books and papers. It must be borne in mind, however, that it requires years for scientific principles to become thoroughly understood and widely disseminated, so that they form a part of common practice. The early native varieties were largely chance seedlings, and there now seem to be very many choice fruits—pears, apples, grapes, etc.—which originated in this way. However, thousands and even millions of worthless wild seedlings, of which we have no record, have grown and perished, and in reality only one here and there excels and survives.

During the first fifty years of the century almost the sole method of breeding was to select seeds from the best fruits and raise numerous seedlings, which, when they fruited, were carefully examined, and those selected for further propagation which produced desirable fruits, of better quality than the parent sorts. One of the earliest systematic attempts of this sort known to the writers is thus described in the Magazine of Horticulture of 1847: "In the fall of 1817, and in the following spring, Governor Edwards planted the seeds of pears, with the design of obtaining new and superior varieties of this fruit. In doing so, he selected the seeds of the best which could be procured, including many sorts, but the number was then very limited compared with our day." This being one of the first systematic attempts in this country to secure improved sorts, it was largely ridiculed. The results obtained, however, were of great value, as from some forty trees thus produced, several fairly good sorts were secured, among them being the Calhoun, Elizabeth, Dallas, Henrietta, and Citron.

In early days, furthermore, up to the fifties, orchards were to some extent made up of ungrafted seedlings. When a particularly good fruit was produced its seeds were carefully preserved and planted, and some varieties were reproduced in the main true to seed. Immense numbers of seedling apples were thus grown, and furnished excellent opportunity for selection, but only a few produced superior fruit or new varieties. In 1845 Rev. Henry Ward Beecher wrote from Indiana to the Magazine of Horticulture: "An immense number of seedling trees are found in our State. Since the Indiana Horticultural Society began to collect specimens of these, more than 150 varieties have been sent up for inspection. * * * Of all the number presented, not six have vindicated their claims to a name or place—and not more than three will probably be known ten years hence."

Improvement by selection, in the strictest sense of the term, has been employed mostly with annual plants, such as wheat, corn, cotton, etc., and the methods used have been gradually perfected in different industries, until in some, as in the sea-island cotton, all growers make annual selections with the utmost care to maintain and perfect the strain they grow. Very careful methods of selection have also been devised to develop and improve corn, and many of the most productive and valuable races are the result of continuous selection through
numerous generations. In such selection the greatest care is taken to secure impregnation with pollen from vigorous, productive plants. To insure this the field in which selections are being made is carefully gone over when the first silks and tassels begin to appear, and all stalks are cut out which are not vigorous and well formed and which do not show indications of being productive. By this practice it is brought about that fertilization is effected by pollen from vigorous, productive stalks only. The final selections are made in the field when the corn ripens, the seed ears being taken from the most productive and vigorous stalks that are true to the type that the breeder is selecting to establish.

In selecting wheat to improve the strain the early attempts were mainly confined to simply taking the largest grains—a practice which is now recognized as failing in the primary factor of considering the productivity and vigor of the individual plant. Many experimenters in this country have worked on the improvement of wheat by selection, but in general with rather indifferent success. Recently, however, Professor Hays, of the Minnesota Agricultural Experiment Station, has used a very careful method of selecting wheat, grown in nursery form, which has given valuable results.

Hybridization and cross-fertilization in improving plants were very little utilized in the first half of the century. Knight had started the leaven, however, and in some directions it had shown results. The idea gradually became current that there was too much chance in raising seedlings of unknown parentage. Still, as late as 1857, we find the Rural New Yorker giving the following directions in regard to raising new fruits: "Eminent pomologists disagree on this subject. Our advice, however, is to plant the best seeds of the finest varieties, take good care of the plants, and trust to Providence for the result." Considerably before this time, however, the most advanced plant breeders had given rather different directions. In 1836 A. J. Downing, one of America's best-known pomologists, wrote: "Assuming Professor Van Mons to be strictly correct, we would suggest that a great saving of time and a considerable improvement in quality and vigor, might be gained by calling in cross fertilization to the aid of the cultivator, as soon as the fruit of the trees (say the second generation) begins to show symptoms of amelioration. By impregnating them with the pollen of the finest varieties, we conceive that the next generation would produce excellent fruit, and at a saving of twenty or thirty years." In 1844 C. M. Hovey, one of the most successful of all American horticulturists in the production of improved sorts, said with regard to the grape: "Without stopping to institute an inquiry into the merits of his [Van Mons] theory, compared with that of artificial impregnation, as practiced by Mr. Knight and others, we shall recommend to those who would raise seedlings, the importance of commencing with the Isabella or Catawba, for one of the parents,
and impregnating them with the Sweet Water, Chasselas, or some other early foreign variety. The results will be obtained in a shorter period, and, we believe, equally as favorable as by the method of successive generations alone."

In 1860 Marshall P. Wilder, in his presidential address before the American Pomological Society, gave advice regarding the origination of varieties in almost exactly the same words that might be used to-day: "It was my first, so it shall be my continual and last advice;—Plant the most mature and perfect seed of the most hardy, vigorous, and valuable varieties, and, as a shorter process, ensuring more certain and happy results, cross or hybridize your best fruits."

The first record which we have been able to find of the production of a hybrid variety in America is given by Manning, in the History of the Massachusetts Horticultural Society, as follows: "Probably the first attempt in this country to produce a new fruit by cross-fertilization was by William Prince, who raised the Prince's St. Germain [pear] from seed of the old St. Germain impregnated by the White Doyenne, about 1806." One of the most successful early attempts in using hybridization was by C. M. Hovey, in the improvement of the strawberry, his first hybrid seedlings having been brought to notice in 1838. He was eminently successful in obtaining good varieties by this method, and his success led to the extensive use of hybridization in the improvement of this fruit.

In this connection, it is interesting to note that a striking success achieved by any intelligent cultivator in producing valuable varieties of any plant has often led to the general adoption of his particular methods by other breeders of the same plant. Van Mons's success in originating pears by selection led to this method being mainly used in breeding this fruit. Allen's success, in 1854, in producing a good hybrid grape doubtless stimulated the adoption of this method in preference to other methods in improving the grape.

Since the middle of the century the advance in methods of improving plants has been altogether in minor factors. The early hybridizers often used a mixture of pollen, believing that it was possible for the same seed to be influenced by pollen from several varieties, or species. The details of the process of fecundation were not well worked out at that time, and it is not surprising that early experimenters frequently erred in their conclusions and were thus led to pursue false methods. With the gradual increase in knowledge of the methods of fecundation the idea of the effectiveness of using two kinds of pollen at the same time was abandoned, and in casting about for other methods of securing the results sought growers evidently began the practical use of compound hybrids, as the method came into practice about this time. Numerous hybrid rhododendrons, begonias, etc., contain the blood of several species, mingled with the definite idea of securing in the offspring certain characteristics from each parent. Compound hybrids
have been particularly valuable in grapes, among the numerous excellent sorts of such hybrids being Lady Washington, Brighton, and Brilliant.

Another important factor in the application of hybridization to securing improved strains, and one which has but very recently become prominent, is the securing of what have been termed dilute hybrids, that is, hybrids containing more blood of one variety than of the other. If in any hybrid the character of one of the parents is found to be too pronounced to give a successful combination, it is crossed with the other parent, the result being a three-fourths hybrid, that is, a hybrid deriving three-fourths of its characters from one of the original parents and one-fourth from the other.

The value of selecting distinct parents and introducing new species into combination with old ones was early recognized, but mainly among florists, where a change of color was desired. In 1836 Hovey called attention to the change in color produced in calceolarias by the introduction of a different-colored species. "It was not until the introduction of a purple species, C. purpurea, in 1827," writes Hovey, "that any variation took place in the color of the flowers; the previously introduced ones being yellow, of course no other shade was produced until the impregnation of the former with the latter. At the present time, however, plants are to be found of almost every tint, from the palest yellow to deep orange, and from light red to bright scarlet, as also, two or three of these shades distinct in the same flower." The results of more recent work have emphasized the importance of using very distinct parents when marked changes or new creations are desired. The improved strains of begonias and roses resulting from the introduction of Begonia socotrana, Rosa rugosa, and R. wichuraiana, and Burbank's walnut hybrids (crosses of Juglans californica, J. regia, and J. nigra) illustrate the importance of this practice. This has led in recent years to the extensive introduction of and experiments with various wild species of common cultivated plants, and the field here opened to the horticulturists and florists is one of promise.

The importance of growing hybrids through several or at least two generations, in order to secure greater variation, particularly where the hybrid is from widely distinct parents, was scientifically demonstrated by Naudin and Nägeli in 1865. The practical importance of this discovery, however, has come to be thoroughly understood and appreciated by American plant breeders only in the closing years of the century.

In very recent years there has been much discussion of the question of the improvement of certain cultivated plants by selection of the vegetative parts used in propagation. It seems to have been proved beyond question that certain plants can be greatly modified in this way, particularly as to vigor and productiveness. This method
of improvement seems likely to play a very important part in the future by aiding to secure strains of standard sorts suitable for growth in special localities and varying but slightly from the original varieties.

IMPROVEMENTS EFFECTED DURING THE NINETEENTH CENTURY.

In the present paper it is possible to call attention to only a few of the most important improvements illustrative of the advances made in certain fields of agriculture and horticulture. In early days, as previously indicated, the majority of the native varieties introduced were merely chance seedlings, which grew uncared for until their good qualities were discovered, when they were brought into cultivation. The sorts obtained in this way are not primarily due to plant breeding, being simply the result of intelligent choice of chance-sown plants, yet some of these varieties have had a marked influence on the development of certain industries. Of far greater importance, however, has been the introduction of varieties which have been produced by careful methods of selection, carried through from one to many generations.

Hybridization also has already had a very marked effect in the development of many cultivated plants, and in the future it will doubtless be extensively utilized in securing desired modifications.

IMPROVEMENT IN GRAPES.

The grape has been very much improved by American cultivators and furnishes an excellent illustration of the great amelioration which may be obtained in a comparatively short period. For many years after the settlement of America the only grapes cultivated were of European origin. Numerous trials, however, proved that these were not hardy in Eastern America, and that they soon succumbed to attacks of Phylloxera and other diseases. Curiously enough the native American grapes, which were found in great abundance throughout the eastern part of the country and attracted considerable attention, were for years neglected, and it was only after the failure of the European sorts had been demonstrated that the native sorts were brought into cultivation. The first of these to attain prominence was the now famous Catawba, which was found wild in North Carolina in 1802, and was brought into general notice by Maj. John Adlum, of Georgetown, D. C. A few years later the Isabella, another wild grape, was introduced, and after the success of these two sorts had been demonstrated many other wild forms were brought into cultivation.

Apparently very little systematic effort was made to improve the grape until the appearance of Pond's Seedling in 1835. The time of its introduction is worthy of notice as being the beginning of a period of planting seeds of the native species for the purpose of making selections.
The greatest advance in grape culture in this country is without doubt due to the famous Concord, which was also produced by selection. About the year 1840, Mr. Ephraim Bull, of Concord, Mass. (Pl. XXXVI), found growing on his grounds a wild grapevine, which was apparently a seedling from some wild grapes that had been scattered about his place by boys the preceding year. He took up the vine and moved it to his garden, giving it good care until it fruited in 1843, the fruit, which was of good quality, ripening as early as the latter part of August. He was so impressed with the superior quality of this fruit and the lack of foxy flavor that "the idea at once occurred to him that another generation would be a still greater improvement." Following this out, he planted seeds of this grape, obtaining a number of seedlings. One of these, which fruited first in 1849, was so markedly superior to the others that it alone was preserved, later being named the Concord. This grape, because of its vigor, productiveness, and fine quality, at once became very popular. Not only has the variety proved of great value itself, but it has been the parent of a great number of varieties, many of them of considerable merit. Probably the best known of these are the Worden and Moore's Early Mr. Bull continued to plant seeds of the Concord year after year until he had produced over twenty-two thousand seedlings, but of these there were only twenty-one which he recommended for cultivation, and none of them have become as popular as the parent variety.

In the last twenty years very many varieties of the grape have been produced, but no select seedlings of striking importance have appeared, the good new varieties being mainly hybrids. In this connection it is worthy of notice that the grape owes more to hybridization than does any other fruit. The Delaware grape, which is even yet a standard of excellence, is probably a natural hybrid, containing some blood of the fine European grape. This was found in a garden of foreign grapes in New Jersey about the year 1850, but received its name from Delaware, the Ohio town in which it was first brought to general notice. It is undoubtedly the best of our chance seedlings, and was the last introduced that proved of much merit.

Many of our most widely cultivated varieties of grapes, such as the Salem, Niagara, Brilliant, etc., which are common sorts in the markets, are the results of careful hybridization. The first hybrid grape produced in this country, known as Allen's Hybrid, was introduced in 1854, and was a cross of the Isabella with a European variety, supposedly Golden Chasselas. This is the epoch-making grape as far as hybrids are concerned. It was regarded with much interest because of its fine quality and appearance, and while the bright hopes regarding it were never realized, it was of the greatest importance, as it served to stimulate the improvement of grapes by hybridization. Shortly after this E. S. Rogers, of Roxbury, Mass., began introducing his new hybrid varieties, the first being sent out in 1856. His Salem
is an excellent chestnut-colored sort, and is probably the most extensively grown of any hybrid grape. Rogers was closely followed by Ricketts, Burr, Caywood, Moore, Rommel, Stayman, and several others, who were very active in the production of new sorts, mainly hybrids, and more recently still, by T. V. Munson, of Denison, Tex., who has probably conducted the work on a more extensive scale than any other experimenter in this field. Munson has already sent out thirty-six new varieties, for the most part hybrids, and is still actively engaged in the work.

A tabulation of the grapes described in Bush & Son & Meissner's Grape Grower's Manual shows that, of 554 varieties described, 287 are hybrids, 141 select seedlings, 57 chance seedlings, 68 of unknown origin, and 1 a sport. Considering those of known parentage, 59 per cent are hybrids, 29 per cent select seedlings, and 12 per cent chance seedlings. These figures show the marvelous extent to which hybridization has affected the improvement of the grape.

IMPROVEMENT IN PEARS.

One of the first native varieties of pears to be introduced was the Seckel, which has remained to the present time our standard of excellence. It was found near Philadelphia during the eighteenth century, apparently being a chance seedling. Many other early native varieties introduced were obtained in this way, among them Tyson, Andrews, and the Columbia Virgoulouse, the last named remaining a popular pear for a considerable time. It was not long, however, before the practice of planting seeds of the best fruits and selecting from the resulting seedlings came to be adopted in the improvement of the pear. One of the first attempts of this kind to attract attention was that of Governor Edwards, of Connecticut, as mentioned elsewhere. Probably the most systematic and successful attempt at growing seedlings for selection was that made by Mr. Dana, of Massachusetts. He planted seeds of the best varieties and raised five or six thousand seedlings, from which he obtained many good varieties, the best being Dana's Hovey, introduced about 1860. It is worthy of note that Dana always planted the seeds of the best varieties, a practice directly opposite to Van Mons's theory, and yet succeeded in producing many good sorts.

The pear owes but little of its development to artificially produced hybrids, and yet in no other fruit have hybrids played such an important rôle. The Kieffer, Le Conte, and Garber, all widely-grown commercial pears, through which this industry has been greatly extended, are naturally-produced hybrids of the European pear and the Chinese sand pear.

The European pear, noted for its excellent quality, succeeds admirably on the Pacific coast, but has never proved wholly satisfactory in the Eastern States, and can not be successfully grown on a commercial
scale south of Virginia. The Chinese sand pear comes from a region having climatic conditions very similar to those of the Eastern and Southern States, and thus finds here a congenial home. The fruit is of poor quality, however, and the variety is grown only as an ornamental tree and for stocks on which to bud other sorts. The Kieffer and Le Conte are both seedlings of the Chinese sand pear, and from their characters show that the seeds from which they grew must have been accidentally crossed with the pollen of some good variety of the European pear. It is probably to the father parent, the European pear, that is due the improved quality of the fruit, while the vigor and adaptability to growth in warm climates evidently come from the mother parent, the sand pear. These hybrid sorts practically revolutionized pear culture in the Eastern United States, extending the limit of profitable commercial pear growing several hundred miles southward. From Virginia to Florida these varieties grow luxuriantly and have practically driven out all other sorts. Even as far north as Philadelphia the Kieffer is by far the most important commercial variety.

**Improvement in Apples.**

Among apples, as in the case of pears, the variety that is considered to be a standard of excellence, the famous Newtown Pippin, was obtained as a chance seedling. It was introduced to notice about two hundred years ago. The Baldwin apple, which has exercised such an important influence on the apple industry, was also a chance seedling, which sprang up about 1742 on the farm of Mr. John Ball, in eastern Massachusetts, and was brought into general notice by a Colonel Baldwin, from whom it took its name. This apple proved to be of such importance that its origin has recently been commemorated by the erection of a monument on the spot where the original tree stood.

Many other chance seedlings have proved to be of great value, but a large proportion of the varieties of most importance, obtained during the nineteenth century, are the results of selection either of seedlings grown for the purpose or from seedling orchards. Of these may be mentioned the Northern Spy, originated in New York about 1800; the Jonathan, introduced in 1829; the Summer Bellflower, and many others.

One of the important problems which has recently taxed the skill of apple breeders has been to secure varieties suitable for growth in the northwest prairie region. The Wealthy apple, the first variety to meet this condition, furnishes one of the most striking examples of improvement in apples effected by planting numerous seeds and selecting from the seedlings. About the year 1855 Mr. Peter M. Gideon, of Minnesota, began fruit culture, planting fruit trees of various kinds, among them thirty named varieties of apples, and also a bushel of apple seeds. Each succeeding year for nine years he
planted more trees and also enough seeds to produce about a thousand trees each year, but the cold winters kept killing them off until at the end of the ten years there was left only one small seedling crab. All of Mr. Gideon's neighbors gave up the attempt to grow fruit, characterizing it as an impossibility, and urged him to do the same, but he persisted and sent to Bangor, Me., for scions and seeds. From the seeds of the Cherry Crab thus obtained one seedling proved hardy and was named the "Wealthy." Upon these varieties the apple culture of the northern Mississippi River region has been built. Within very recent years there has been great activity in hybridizing our different varieties of the apple with the varieties of Russian apples recently introduced and with the native wild crab, the object being to obtain hardier varieties. This line of experiment, started in the closing years of the century, will probably in a few years yield results of the greatest practical value.

IMPROVEMENT IN PLUMS.

For many years plum culture in America was almost entirely limited to the cultivation of introduced varieties of the European plum, but little attention being given to the origination of native sorts, as, in the main, the finer foreign sorts succeed fairly well in the limited area in which the European plum can be grown. Nevertheless, some attempts were made, and in Canada Henry Corse grew thousands of seedlings

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Fig. 22.—Plums showing difference between hybrid and parent: Hybrid plum Golden at right and mother parent Robinson at left, natural size (after Burbank).
for several years previous to 1840 with the hope of procuring something which would excel existing varieties. From this great number he selected several which promised well, and to four, of whose excellent quality there was no doubt, he gave the names Dictator, Victoria, Colonel Wetherell, and Nota Bena. About the middle of the century the value of our native species came to be recognized. Many selected chance seedlings were brought into cultivation, and it is to these that we owe the development of our native species of plums, nearly all the best-known varieties of which were obtained in this manner.

It is only recently that any attempt has been made to improve our plums by artificial hybridization, and this attempt has been brought about mainly by the introduction of the Japan plum (Prunus triflora), which has entered into most of the valuable combinations thus far produced. The first Japan plum grown in this country, the Kelsey, was not introduced until 1870. The great activity in introducing the Japanese varieties and crossing them with American sorts did not begin, however, until several years later, but, according to Professor Waugh, the Japan plum already constitutes one parent of twenty-seven hybrids which have been found valuable and named. The introduction of this plum and its use in hybridization bids fair to be of the greatest importance to the plum industry. Luther Burbank, of California, was the pioneer in plum hybridization, and has produced very many valuable sorts, such as the Golden (fig. 22), Juicy, and America (crosses of Robinson with Botan). The apricot plum, another species, has also been used a number of times by American experimenters in crossing with the Japan plum, and has yielded such fine combinations as the Climax, Chalco, Late Conical, and probably the Wickson, all of which were produced by Burbank. Some valuable hybrids of our native species have also been produced, but they are not so promising as hybrids with the Japan plums.

IMPROVEMENT IN RASPBERRIES.

The varieties of raspberries cultivated in this country are almost entirely of the native species, it having been found difficult to grow the European varieties. Accordingly, we find that our first varieties are derived mostly from wild plants picked up in the woods and the fields and brought into cultivation. Among those thus cultivated, probably the first to be named and generally distributed was the so-called English Red, which was really a native American variety. Among other chance seedlings are the Ohio Everbearing, Catawissa, and Cuthbert. The last named was found growing in a garden in Riverdale, N. Y., in the latter part of the seventies, and soon became a popular sort.

The systematic improvement of the raspberry by growing seedlings for selection was much retarded by the earlier growers of this fruit attempting to make use of the European instead of the native species.
In the meantime, however, many wild plants of the American species were domesticated on farms and in gardens. Among the early experimenters with this fruit was Dr. Brincklé, of Philadelphia, who produced a great many varieties, but only one which proved important. This was the Brincklé’s Orange, produced in 1844, from an English sort known as Dyark’s Seedling. It has proved to be a very popular berry, and has been widely grown, being one of the very few varieties of the European species to prove hardy in America. Soon there appeared other varieties, many of them being seedlings of foreign sorts, but probably in many cases accidentally crossed with the native species. Most of the varieties now grown, however, are improved varieties of the American species.

In the last quarter of the century several valuable hybrids have been introduced which have become popular sorts. Among these may be mentioned the Dictator (Gregg crossed with Schaffer) and the Caroline (Brincklé’s Orange crossed with Black Cap).

**IMPROVEMENT IN BLACKBERRIES.**

The blackberry, as a cultivated plant, is entirely an American production, and we owe nothing to the European plant breeders so far as it is concerned. All the earlier varieties were merely wild plants taken up and set out in the garden. One of the first attempts to improve the blackberry was that by Mr. Lovett, of Massachusetts, who for many years attempted to find good plants and bring them into cultivation. It was not until 1850, however, that the Dorchester, the first variety to be named, was introduced. In 1854 a berry was introduced that marked an epoch in blackberry culture, and showed what the fruit was capable of becoming. This was the Lawton, or New Rochelle, as it is often called. It was found by the roadside near New Rochelle, N. Y., and was introduced by Mr. Lawton. This berry long remained popular, but its place was finally taken by Wilson’s Early, also found as a wild plant.

The culture of the blackberry is still in its infancy, and comparatively little attention has been given to its improvement. Quite a number of hybrid varieties, such as Iceberg, Autumn King, Minnewaska, etc., have been introduced, but none have as yet become very well known.

The raspberry and blackberry have been repeatedly hybridized by experimenters like Burbank and Carman, and some suggestive results obtained. Burbank’s series of raspberry-blackberry hybrids are in many respects the most remarkable ever produced between distinct species. The most noteworthy of these hybrids are Primus (Western dewberry crossed with Siberian raspberry), Paradox (Crystal White blackberry crossed with Schaffer raspberry), and Humboldt (Improved California Wild dewberry crossed with Cuthbert raspberry). Burbank, in speaking of the Primus, says: “It is also remarkable that
the hybrid should ripen its fruit several weeks before either of the parents, and excel them much in productiveness and size of fruit, though retaining the general appearance and combined flavors of both.” The Paradox was the only one retained out of some forty thousand hybrid seedlings.

**IMPROVEMENT IN STRAWBERRIES.**

Strawberry culture in this country was conducted on a small scale at first because no varieties well suited to the climatic conditions were known. Many were tried without success, especially the Keen’s Seedling, which was represented as very promising; but while it was an exceedingly valuable berry in England, its place of origin, it failed to fulfill the expectations of those who imported it into this country. After cultivating this and many other sorts of more or less note, Mr. C. M. Hovey, an eminent American pomologist, became satisfied that there existed in this country at that time no variety possessing the qualities necessary to make its cultivation profitable. “There seemed to be wanting,” says Hovey, “a variety combining the qualities of two or more of these, and we set out upon the experiment of attaining this desirable result, determined, if time would allow, to pursue it until our object was accomplished.” He prepared plants of seven distinct varieties, and in 1833 made six series of crosses, having first carefully removed the stamens from the flowers to be pollinated, so as to prevent self-fertilization. The following year the resulting seeds were planted and produced plants of very varied appearance and characteristics. Only a few of these surpassed the best of the parent varieties, but one in the size and number of its berries, as well as in fine flavor, excelled anything known in this country. This plant was kept under observation six years, at the end of which period, having fulfilled the expectations of its producer, it was put on the market under the name of Hovey’s Seedling (fig. 23).

The effect of the production of this berry was truly wonderful, and resulted in making strawberry culture popular and profitable. Other experimenters began to make crosses and to grow new sorts, but in spite of the almost innumerable varieties thus produced Hovey’s Seedling remained the leading berry for almost thirty years. It is worthy of note that although it was probably the most famous variety ever produced, it is now extinct, it being impossible to obtain typical plants,
IMPROVEMENT OF THE NATIVE GOOSEBERRY: 1, RIBES OXYACANTHOIDES, WILD FORM; 2, HOUGHTON GOOSEBERRY, SEEDLING OF THE WILD FORM; 3, DOWNING GOOSEBERRY, SEEDLING OF THE HOUGHTON. (ALL NATURAL SIZE, ADAPTED FROM BAILEY.)
The Wilson, which supplanted it, is itself being gradually supplanted by other sorts, and will probably eventually disappear. Among the varieties produced from Hovey's Seedling may be mentioned Moyamensing Pine, which in 1849 was awarded the prize offered by the Philadelphia Horticultural Society for the best new berry. This was in turn the parent of many other varieties, some of which were of considerable merit.

Hybridization has been the favorite method of producing new varieties of strawberries, perhaps because the first successful variety was obtained in this way. Among the recent hybrids may be mentioned the Hunn, which also illustrates the difficulty of systematic breeding, it being the only one deemed worthy of preservation out of about seventeen hundred hybrid seedlings tested.

**IMPROVEMENT IN GOOSEBERRIES.**

As in the case of most other fruits, the first varieties of gooseberries grown in this country were of foreign origin. However, these mildewed very badly, especially when their cultivation became more general; hence, in the course of time the growing of this fruit was almost totally abandoned. Soon the native species began to attract attention, however, and one of the first varieties to be described was Houghton's Seedling, produced near Lynn, Mass., about 1845, from the wild gooseberry. A few years later Mr. Downing, of New York, produced from this already popular variety the Downing, a seedling which has since become extremely popular. The Houghton and Downing, compared with the wild type from which they sprang, furnish an interesting illustration of the evolution of a native wild plant. (Pl. XXXVII.) Since then a number of seedling varieties of good quality have been produced, and have come to be quite extensively cultivated. However, now that the use of fungicides has become general, the English varieties are again coming into cultivation, and it is still a question whether the advantage gained by the American varieties, owing to the exclusion of the former by mildew for so many years, will enable the American sorts to retain their supremacy.

**IMPROVEMENT IN VEGETABLES.**

The Tomato.—The tomato illustrates well what can be accomplished by careful breeding. In the early part of the century the races of tomatoes had mostly small and lobed fruits, but in the course of fifty years or more of selection the type has changed until the fruit is now large and smooth and the habit of the plant very different. As in the case of the strawberry, the first great advance in the development of the tomato in this country was made by hybridization. The Trophy tomato, introduced by the late Colonel Waring, was the first of our modern, smooth, round tomatoes, and its production and
advertising, probably more than anything else, served to make the tomato a popular garden vegetable. "The Trophy tomato," in the words of Colonel Waring, "is a product of crossing and careful cultivation by Dr. Hand, of Baltimore County, Md., who began his work in connection with it about 1850. He crossed the small, smooth 'Love Apple,' which was filled with juice and seeds, with the compound, convoluted tomato of that period. This latter was practically four or five separate fruits packed together in one, with the skin running far into the convolutions. He succeeded in putting the solid mass of this compound growth into the smooth skin of the Love Apple, and then, by careful selection, year after year, increased its size and the solidity of its contents until it became a mass of flesh interspersed with small seed cells." The Trophy remained for a number of years the principal race on the market, but was finally superseded by others bearing larger and better fruits, in the production of which hybridization played an important part. The effect of selection in recent years is illustrated in the production of the Paragon by A. W. Livingston. In passing through a field of tomatoes, he selected one plant because of the uniformly smooth fruits and because of its being very prolific. The seeds from this plant were sown the next year, and the stock of seeds for planting was saved from the earliest and best specimens. By continuing this process for five years the Paragon was produced. The Acme, Perfection, and many other races were originated in a similar manner.

**The Potato.**—The potato has long been the subject of more or less systematic improvement in this country. According to Bailey, even as early as the end of the last century, Joseph Cooper made "successful experiments in keeping and improving strains of the potato." There is a record in 1835 of the production of a new variety called Perkin's Seedling, originated by planting a seed ball a year or two before. In 1841 the Pollard, a seedling of the Chenango, was introduced, but the most popular potato originated during this period was the Mercer, which was also a select seedling. For a good many years after this it was a general practice to plant potato seeds to produce new varieties, but these for the most part remained known only locally.

The introduction of new wild strains from South America marked the beginning of a very distinct epoch in the culture of the potato. About 1850, or possibly two or three years earlier, a Mr. Goodrich began experiments with a view of improving the potato, using the varieties known as the Wild Peruvian and the Rough Purple Chili, which were either direct importations from South America or but slightly improved. He grew seedlings of these varieties for fifteen years, obtaining over sixteen thousand, but considered only ten of this number worthy of cultivation. The best two of these were the Cuzco, a seedling of the Wild Peruvian, and the Garnet Chili, from the Rough Purple Chili. Later the Cuzco gave rise to several fairly
valuable varieties, but it was surpassed by the Garnet Chili, from which several of our best-known varieties have been produced.

In 1860 or 1861 a grower of the Garnet Chili preserved a seed ball of this variety, pinning it up against his window until it was old and dry, when, fortunately for the potato industry of the United States, he gave it to Mr. Albert Breese, of Vermont. Mr. Breese planted the seeds and obtained widely varying plants, some producing many tubers and others but few, while there was no uniformity in their size or shape, some being large and others small, some round and others elongated. Seven of the plants proved to be of exceedingly good quality, but one of these, an early sort, far surpassed the others and was named the Early Rose. When this potato was put on the market a few years later, it commanded almost fabulous prices, and in a few years became the leading variety in America, a position which it still retains over a considerable part of the country. The other varieties of similar origin also became quite popular, and soon the old sorts were completely abandoned. In fact, there can be found in the catalogues of varieties grown at the present time scarcely a single variety popular forty years ago.

In the production of many sorts, such as the White Elephant, Snowflake, Nebula, etc., hybridization has been used, but so far none of the varieties thus produced have proved as valuable as the Early Rose.

The potato has been also somewhat improved by the selection of its tubers. Thus, when the Early Ohio was introduced, a careful selection was made of the "medium-sized, well-ripened tubers of a desired shape," with the result, according to C. L. Allen, of "fully a week's gain in earliness; a great increase in productiveness, with a marked decrease in the quantity of vines." A few of our well-known varieties originated as bud sports from the tubers; for example, Thorburn's Late Rose from tubers of the Early Rose.

The Garden Pea.—The garden pea furnishes an example of great improvement produced largely by hybridization, the most marked result obtained in this country being the production of the dwarf pea American Wonder about the year 1880, up to which time the varieties grown were almost all of foreign origin. This variety was the result of a combination of McLean's Little Gem and the Champion of England. The former long stood at the head of the dwarf peas, but was unproductive; the latter at the time the cross was made was considered the best in quality and the most productive of the tall peas. The American Agriculturist says: "We look upon the production of this pea as one of the most important steps made of late in its department of horticulture."

The Squash.—It is interesting to note that among squashes, which hybridize so readily, the Butman, originated by Mr. Clarendon Butman, of Maine, about 1875, was the result of crossing the Hubbard
with a Japanese race and of several years of careful selection. This, according to Mr. James J. H. Gregory, was the first instance of a race of squashes produced in America, all of our standard races previous to the production of this one having been originated abroad.

**IMPROVEMENT IN CEREALS.**

Corn.—Corn has probably been more or less the subject of improvement by selection ever since it was first cultivated, and it is a general practice among farmers who grow their own seed to select the best ears for the next year’s planting. There have been some experimenters, however, who have given special attention to its improvement, among the earliest being Mr. J. S. Leaming, who began in the early fifties by going through his fields—then producing an ordinary, not very prolific, yellow corn—and selecting seed from the best-formed plants bearing two or three well-formed ears. In this way, by a continuous selection extending over thirty years, the famous Leaming corn was produced and kept up to its standard. About fifteen years later Mr. James Riley, of Indiana, also began the careful selection of corn, taking a fine white sort as the original. He used essentially the method followed by Leaming, but in addition went through the fields just as the tassels were appearing and cut out all imperfect and barren stalks. He selected seed for the next year’s planting from the finest stalks and the best and most evenly developed ears. By continuing this selection for several years he produced the Boone County White (Pl. XXXVIII, fig. 1), which has given noteworthy yields at the Illinois experiment station.

Corn has been greatly modified and improved by hybridization, but no improvement stands out as marking a distinct epoch. The earliest account of a new race being originated by hybridization which has come under the notice of the writers is that of the Smith’s Early White, described in a letter by Dr. Gideon B. Smith, in the Albany Cultivator for 1838, the experiments being said to have been started some ten or twelve years earlier. It was the result of a cross between the Tuscarora and the Sioux. Dr. Smith’s discussion shows that the results to be expected from crossing different races of corn were thoroughly understood even then. The original Old Colony sweet corn, a race originated about 1849, and extensively cultivated for years, was one of the first and best of the sweet-corn hybrids.

The ease with which corn hybridizes naturally in the field has led to great mixing, and doubtless many forms now cultivated are selected types of such accidental crosses. Very many of the best races, however, were originated as carefully produced hybrids.

Wheat.—The early races of wheat grown in this country were, as was the case with almost all our cultivated plants, of foreign origin, and even now a great many sorts are being imported, especially from Russia. A large number, however, have had their origin in America,
Fig. 1.—Improvement of Corn by Selection: Boone County White Corn on Left and Original Type from which it was Developed by Selection on Right.

Fig. 2.—Variation in Seedling Pecans: Frotscher Pecan on Left and Two Seedlings from it, Showing Variations in Thickness of Shell, Size, etc. (Natural Size.)
the first of these being mainly such as originated in fields of wheat or from chance-sown seeds, which, owing to their differences from other wheat, were preserved and perpetuated. Such, for example, were the Tappahannock, found in Virginia in 1854, and the famous Fultz wheat, found in a field of Lancaster Red wheat in Pennsylvania in 1862 by a Mr. Abraham Fultz. Mr. Fultz was attracted by some beautiful heads of smooth wheat, which he saved and planted by themselves, and from these the new race was developed.

But little attention has been given to the systematic growing of wheat for selection until quite recently. The most important experiments of this kind in the United States are those by Prof. W. M. Hays, of the Minnesota experiment station, which are still in progress. From the year 1888 up to the present year 552 different races have been tested, from which eight were finally selected as worthy of preservation. From these eight, selection experiments were started in 1892, and as a result, even at the end of the first year, four of the best eight new strains surpassed in yield and in some other qualities the best four of the old varieties. Though it is too early yet to give more definite results, it is evident that the use of selection is very promising as regards the improvement of even the best races.

Within recent years considerable attention has also been given to hybridization, and many valuable hybrids have found places in our lists of important races. Attention has been directed mainly to increasing the yield by crossing different strains and to securing earlier and hardier sorts. Among the earlier experimenters in this field Arnold and Pringle were eminently successful. Arnold’s Hybrid No. 9, a cross of Michigan Amber with White Soules, has in some places given good results. Pringle’s Defiance, said to be “a hybrid of a white wheat common in California upon an Eastern club variety,” has proved very valuable in California, Colorado, and other places. Prof. A. E. Blount, while at the Colorado experiment station, made many wheat hybrids and obtained several improved varieties. Blount’s Hybrid No. 15, a cross of Lost Nation with Sonora, has become a well-known race, giving excellent results in some States. Probably the most valuable work in wheat hybridization in this country has been done by A. N. Jones, of New York. Mr. Jones writes: “Most of my crossbreeds are from Russian and American varieties, with some blood from Mediterranean Longberry or offspring from these combinations.” Of the sixteen or more hybrid wheat races introduced by Jones, several have become standard sorts. Winter Fife, which is extensively grown in Indiana, Ohio, and other places, is probably his best-known race. His Early Red Clawson, Early Genesee Giant, etc., are among our widely grown races.

From 1888 to the present time Prof. William Saunders, director of the experimental farm, Ottawa, Canada, has been hybridizing wheats particularly to secure early ripening races. To accomplish this he
has sought to secure earliness and hardiness in the best American races by hybridizing them with various Russian sorts. Preston and Stanley, derived from Ladoga, a Russian sort, crossed with Red Fife, and Alpha, Percy, and Advance, derived from Ladoga crossed with White Fife, are proving valuable additions. Tests of Preston and Advance at the Minnesota experiment station have given good results. Professor Hays, of that station, says: "Preston is the most interesting and promising variety of wheat procured outside of the State, and it bids fair to be a strong rival of our best Fife and Blue Stem wheats." Besides his important work on selection mentioned above, Professor Hays has been in recent years conducting experiments in hybridization and has obtained results of the greatest promise. It is noteworthy that in this country the wheat hybrids thus far produced which have given valuable results are racial hybrids, in many cases very complex, including several different races.

OATS.—No oat hybrids produced in this country have as yet become very important so far as the writers are informed, although some are of exceptional interest, as, for instance, Pringle's Excelsior, a so-called hull-less oat produced by crossing the common Chinese Hull-less (Avena nuda) with the Excelsior, a race of the common oat. This remarkable hybrid is said to possess the strength and robust character of the common oat and to retain the peculiarity of the naked seed derived from the Chinese Hull-less. It was introduced about the year 1881, but does not appear to have proved satisfactory for general culture. Recently Garton Bros., of England, have introduced a similar "naked oat," which gives great promise of proving a valuable sort, particularly for the preparation of oatmeal and similar foods. Apparently hybridization in this line promises important results.

IMPROVEMENT IN FLOWERS AND ORNAMENTAL PLANTS.

In no plants has scientific plant breeding been carried further than in those grown for their flowers or for ornamental purposes. Growers of such plants are compelled to produce new and striking varieties and races, and so must take advantage of all available methods.

An interesting example of the result of continuous selection is the Blanche Ferry sweet pea, which resulted from over twenty-five years of selection from the old Painted Lady, in northern New York. In successive years the plants gradually became more stocky and compact, until after ten or twelve years they needed no outside support. From the Blanche Ferry there have arisen independently at least two of the dwarf varieties known as "Cupids." These arose as seedling sports and soon became very widely diffused.

Probably in no other plants has hybridization given such marked results as in those cultivated for their flowers. This is due largely to the fact that in such plants variation of form and color of flowers are the greatest desiderata, and such modifications are most easily obtained...
by hybridizing different-colored species, varieties, etc. Orchids, roses, begonias, chrysanthemums, cannas, and many other of our common flowers have been crossed and recrossed until it is frequently impossible to determine their origin. In this country probably the most attention has been given to roses, carnations, and chrysanthemums. It is to hybridization, directly or indirectly, that we are indebted for almost all the beautiful forms of these flowers. By the introduction of foreign species and their utilization in hybridization with those already in cultivation, new and almost totally different strains are frequently produced. As an illustration of this may be mentioned the important results that have been produced by the recent introduction of the hardy roses *Rosa rugosa* and *R. wichuraiana* and their hybridization with our common varieties of roses. Manda says: "By crossing *Rosa wichuraiana* with greenhouse teas the result is astonishing, as the plants are not only hardy, but retain their foliage during the winter. Thus a new race of evergreen roses has been added to our collection, and promises to be the beginning of a new and useful class."

Advantage has been taken of still another principle in growing plants of this class. It sometimes occurs that certain buds give rise to branches that vary abnormally and produce flowers or leaves of a different color or shape from those borne on the rest of the plant. These so-called bud sports can often be perpetuated, and thus give rise to new varieties. In this way many of the cut-leaved forms of various ornamental plants have originated. Perhaps the most striking examples of the production of new sorts by bud sporting are found in certain plants, such as the chrysanthemum, rose, carnation, etc. Many of these are sports merely in color, but in some cases even the form of the flowers and of the leaves is different. It is said that within the last ten years there have been over fifty cases of new varieties of chrysanthemums originated as bud sports.

**IMPROVEMENT IN NUTS.**

Among the native nuts, probably the chestnut and the pecan are the only ones that have received much attention from plant breeders, though Burbank has given some care to improving the walnut. A few varieties of chestnuts have been obtained by the selection of wild trees of desirable quality, though but little more than this has been done. The pecan, however, has received more attention. In its wild state, it varies very greatly in its characteristics, and this has led to the selection of a number of varieties from wild trees because of some special quality, as thinness of shell, small amount of corky substance between the halves of the kernel, productiveness, size, or other good qualities. One of the best known of such selected pecans is the Frotscher, the original tree of which is still standing in Louisiana, and is probably over two hundred years old. Within the last fifty years many growers
have been planting the nuts of this and other varieties and selecting from among the seedlings thus produced those with the best qualities. Pl. XXXVIII, fig. 2, shows the variations and the possibilities of improvement when careful selection is exercised. The systematic improvement of the pecan, however, has just begun.

**IMPROVEMENT IN COTTON.**

The history of sea-island cotton is extremely interesting, as it serves as an example of the possibility of adapting a tropical plant to the conditions of culture in temperate regions. About 1785 seeds of this cotton were brought to Georgia from the Bahamas. Notwithstanding the good care they received and the mild winter, the plants were killed down, but they came up again from the roots, and with this start succeeded in ripening a few seeds before the first frost in the fall. The earliest of these seeds were sown in turn, and by continuing this process of selection the flowering period became earlier and earlier, until now the plants ripen a large proportion of their seeds before frost, even along the coasts of the Carolinas. Besides striving to obtain earlier maturing sorts, very careful selection has for years been made with a view of increasing the length, fineness, and strength of the staple. This selection is regularly practiced by all intelligent growers and to-day it may be regarded as one of the necessary cultural methods. Every year a special patch of cotton is grown from selected seed; the plants in this patch are examined very carefully and the seed of the best individuals retained for planting a similar patch the next year, the seed of the remaining plants being used to plant the general crop. Under such continuous and vigorous selection the length and fineness of the fiber have gradually increased, until it is now recognized as superior to that grown anywhere else in the world and commands the highest price in the market.