An excerpt from

BOTANY READINGS

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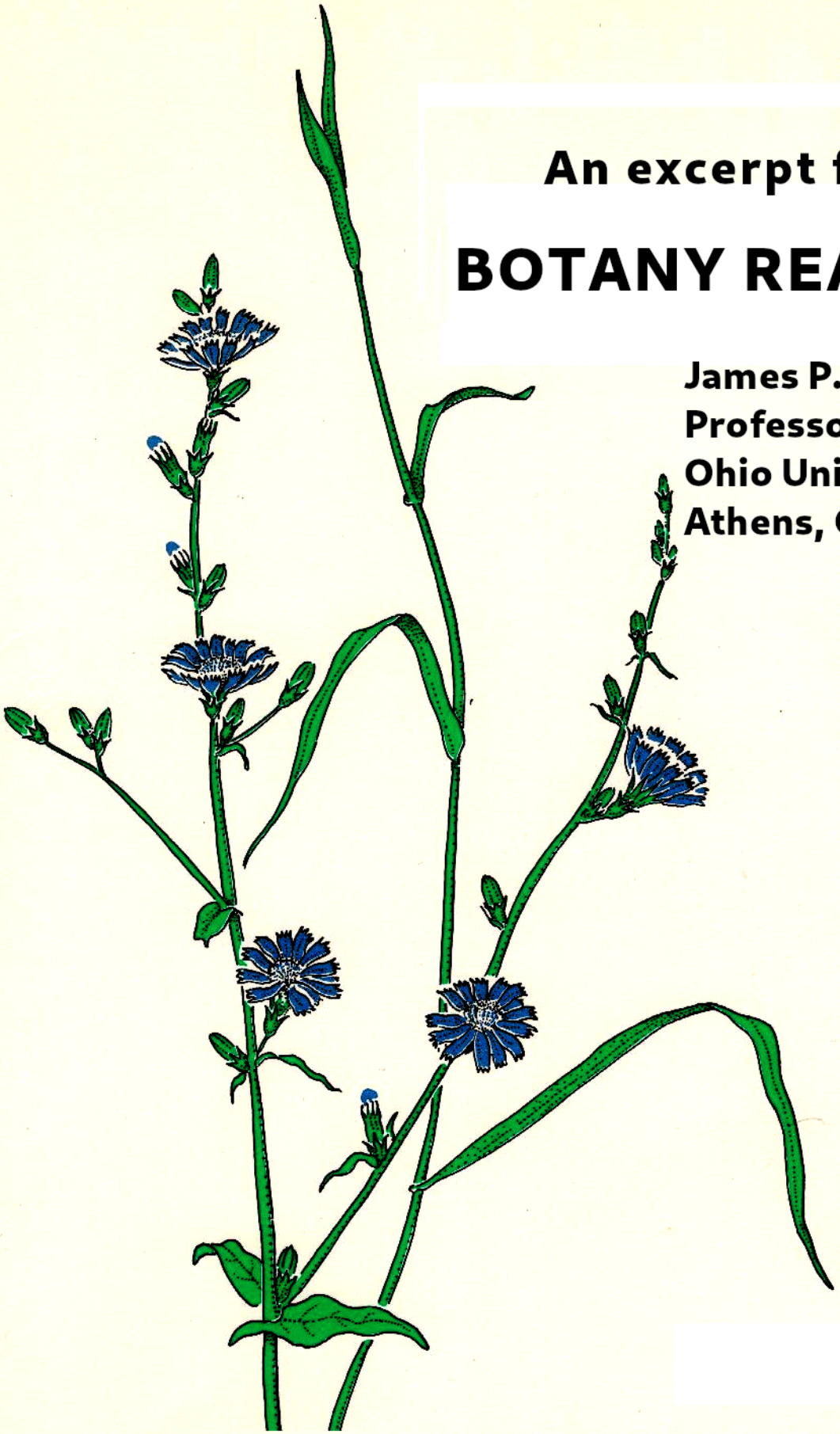

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How Are Plants Propagated?

Reproduction is a basic property of all life. Plants reproduce several ways, and humans have taken advantage of natural reproductive systems to increase the number of plants for human use. There are two major types of reproductive methods: a) **Sexual** and b) **asexual reproduction**.

Sexual Reproduction

Sexual reproduction involves the fusion of two cells (**gametes**) to produce a new cell (**zygote**) which will develop into the new individual. In animals such as humans and also in plants, sexual reproduction involves relatively large, immobile gametes (**eggs**), which are produced by females and small, motile gametes (**sperm**), which are produced by males.

Some groups of plants produce seeds during the sexual reproductive process. The most economically important plants, those plants with which we are most familiar, the flowering plants, produce seeds.

Seeds are produced within flowers of flowering plants: some plants may produce hundreds, even thousands of seeds, during a lifetime. Each seed contains one immature plant (**embryo**) within it. The embryo developed from a fertilized egg, and therefore resulted from sexual reproduction.

Once mature, a seed possibly may remain dormant for up to many years; in the dormant condition the embryo remains relatively unchanged. When a seed is transported to a suitable environment, chemical changes occur within the seed and the embryo initiates growth—this is seed germination.

The new plant that develops from the embryo when a seed germinates resulted from the fusion of an egg and sperm during the process of fertilization. The egg was produced by one parent and the sperm by another. Since the new plant that grows from a seed contains contributions from two different parents the new plant is not identical to either parent. This is a very important point about the offspring produced in sexual reproduction: The new individual is not identical to either parent or to any of its siblings! (Identical twins are the exception to this rule but are explained by the splitting of one young embryo into two.)

Seeds, the major method of reproduction for most of our economically significant plants (e.g., corn, wheat, rice, and soybeans), are products of sexual reproduction. New individual plants produced when seeds germinate may be very similar to their parents and siblings, but the new individuals are not identical to siblings or either parent.

Asexual Reproduction

In addition to producing new individuals by seeds, many plants produce new individuals without the sexual process: This is referred to as asexual reproduction. Most of the ways that plants reproduce asexually fit into what many botanists refer to as either vegetative propagation or cloning. In this set of on-line readings we consider **cloning**, **vegetative propagation**, and **asexual reproduction** as synonyms.

Modified stems are several examples of how plants reproduce asexually. **Bulbs** and **corms** are a common way that plants produce new individuals naturally, and what humans take advantage of for increasing the number of individual plants commercially. In the late summer and early autumn garden stores, department stores, grocery stores, and even some gasoline stations sell bulbs and corms for fall planting. If you plant a bulb of a daffodil bulb and leave it undisturbed, you should notice that after several years a bunch of identical daffodils will flower where you originally planted one bulb. If you carefully dig up the original bulb you would find that there are many small bulbs around it. The original plant had produced new bulbs, hence new plants, asexually. If you were in the business of selling daffodil bulbs you would have increased your inventory just by letting the original plant reproduce asexually.

The important point here is that the new individuals are identical to the original plants. This is a major difference between vegetative propagation and propagation by seeds: **New individuals produced by vegetative propagation are identical to the parent and to the siblings**.

This is an important point when a plant has desirable characteristics such as a delicious fruit, attractive flower, resistance to disease, or unusually rapid growth. Cloned plants are very common commercially since offspring produced from a plant with desirable traits will be identical to it.

Major Methods of Vegetative Propagation

Stems, roots, and leaves are used for cloning plants. The following are some of the major ways that plants are cloned in addition to bulbs which were discussed in the preceding section.

Many plants can be cloned with **cuttings**. A portion of stem with leaves is cut from the parent and placed in a suitable rooting medium for that particular species of plant. Some suitable media include moist sand, a mixture of peat moss and soil, or water. After roots have developed from the cut end of the stem the cutting is transplanted to soil. House plants such as coleus, philodendron, ivy, and geraniums commonly are propagated by cuttings.

Grafting is similar to cuttings in that a portion of stem or in some cases a bud is removed from the parent. The part removed from the parent is called a **scion**. The scion is then attached (i.e., grafted) to a **stock**, which is either a stem or root of another plant. In making a graft it is important to match the vascular cambium of the scion to that of the stock. A graft will fail if the cambia are not in contact. Grafting is used when it is difficult to root cuttings of the plant being propagated, or if the stock has desirable traits not found in the plant that is the source of the scion. For example, roses are grafted onto root stock of wild roses. The above ground part of the rose has the qualities we like in a rose (pretty flowers and pleasing aroma), and the roots resist harsh winters which the original parent of the scion could not do. Grafting is used to combine desirable traits of the scion and stock in grapes also: The scion produces the kind of grape that is desired (e.g., seedless and sweet), and the root stock is resistant to insects that damage roots of many plants. Grafting is also an important means for reproducing plants that do not produce seeds. The best examples here are seedless navel oranges, seedless grapefruit, and seedless grapes.

Rhizomes are used commercially to propagate common plants such as irises and ferns. As the underground stem grows, it branches, thus forming new apical meristems. Rhizomes can be broken or cut into several pieces to increase the number of individuals. Some ferns may attain a very large size through the growth of rhizomes. If one were to observe what is originally believed to be a population of ferns on a hillside, the many groups of leaves may be in reality all part of the same plant with an underground stem, the rhizome. Some ferns called "bracken" in Europe may cover an area over 390 meters in diameter, an illustration that one rhizome may be extensive.

Runners and **stolons** also increase the number of plants asexually. The original plant sends out the modified stems, runners/stolons, which produce new upright branches and roots at the nodes. If the runner/stolon is broken or cut, new individuals are the result. Runners and stolons are used commercially for mints, strawberries, and many grasses.

Tubers, the swollen tips of underground stems, are the major way that potatoes are propagated. Each eye of the potato is a bud at a node. If a small portion of a potato with an eye is planted, a new plant will be produced.

We saw with cuttings that roots can develop from the cut end of a stem. Many plants have roots that will produce a shoot if the root is separated from the rest of the parent plants. Common examples include black locust trees which have roots that readily send up shoots, and sweet potato which are large roots (taproots) that will produce shoots. Anyone who tries to remove weeds from a lawn also is aware of another example of roots that produce shoots: Any missed part of the taproot of a dandelion will develop a new shoot.

Leaves of some plants have the ability to produce both shoot apical buds and roots. In nature these plants increase the number of individuals if a leaf falls onto the ground. New shoots and roots develop and thus a new, cloned individual results. Commercially, plants with leaves that readily form shoots and roots are cut into several pieces so that several plants can be produced from a single leaf.

Technical Advances in Cloning

Methods for cloning plants discussed in the preceding section take advantage of the natural abilities of plants to asexually produce new individuals—the horticulturist merely is helping each plant with what it already does. There are now new ways to clone plants that are in addition to what plants normally would do. In the past few years plant scientists have begun to use methods of biotechnology for commercially producing cloned plants.

Basic studies of plant development have shown that one plant cell can give rise to an entire, new plant if the cell first is grown into a mass of cells (**callus**) under a controlled environment and the callus then treated with special chemicals (plant hormones) that induce development of shoots and roots. Using these tissue culture methods, one parent plant could be divided into thousands of groups of cells, each of which could develop into a callus. Each callus also could be divided into thousands of groups of cells, each of which could develop into a callus. By repeatedly dividing a callus into individual cells and growing each cell into a new callus, in a relatively short time (e. g., several months) from 100,000 to a million potential individual plants would be produced from the original parent. When the time is right, the proper combination of hormones is added to the thousands of calli and roots and shoots develop on each. The young plantlets are transferred to soil and grown to the stage of development for marketing. Since the process of propagating the new plants did not involve sex, each new plant produced is identical to its siblings and to the parent.

Tissue culture methods for plant propagation are carried out in a laboratory. Cells are separated and calli grown under sterile conditions, so the plants that are produced are absolutely disease free. Tissue culture methods continually are being improved and we are seeing more plants each year produced by tissue culture. Douglas fir for tree farms, ferns, African violets, and day lilies are several plants currently propagated commercially through tissue culture.

Summary

The main points to remember about plant propagation are that 1) sexual reproduction results in new individuals that are not identical to siblings or the parents, and 2) asexual reproduction (cloning or vegetative propagation) produces offspring that are identical to each other and the parent. Seeds are the products of sexual reproduction. Major examples of plant parts used in cloning include bulbs and corms, rhizomes, runners and stolons, tubers, and taproots. Tissue culture involves recent advances in plant biotechnology for producing many disease-free individuals from one parent.