move independently of the molecules of every other substance.

The loss of water from plants into the surrounding atmosphere (transpiration) is due to the fact that there are more water molecules from the plant sap bombarding and passing through the membranes separating the interior of the leaf from the atmosphere (intercellular space) than there are water molecules passing into the leaf from that same atmosphere. Should the atmosphere become saturated more water might move into the leaf from the exterior than would be leaving.

Factors which cause the concentration or speed of molecules to change will indirectly affect the rate of diffusion. Thus, the addition of fertilizers (solutes) to soil water (solvent), digestion, a change of temperature, a change in atmospheric humidity will each affect some of the diffusion phenomena described above.

One of the many advantages of the above physical concepts is that they place the action where it belongs: "*the molecule* of water moves into or out of plants" rather than ascribing it to the tissue or organism: "*the plant takes in* and *gives off water.*"

While it is admitted that there are still higher levels of interpretation, the above explanations more nearly approximate the facts than those more frequently used and therefore are more stimulating to further inquiry. They certainly lead the student to a better understanding of his universe.

Nursery Inspection—A Form of Applied Biology

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Biology teachers are frequently called upon to justify their teaching subject in the school program. They should also be prepared to point out to their students, especially those interested in following up biology as a career, the multitudinous ways in which biology plays an important part in the broad fields of medicine, agriculture, plant and animal industries, and conservation. In recent years more and more emphasis has been given to the economic and cultural aspects of biology. It is realized that for the general student it is much more important to understand the role of biology in his civic life than to know the details of earthworm anatomy or the names of frog musculature. Textbooks often devote a chapter to the importance of biology to the welfare of modern man. The common applications are well known, but little or nothing has been written about the field of nursery inspection which should receive attention by educators.

Nursery inspection is important in the field of biology teaching for three reasons. First, landscaping is no longer confined to wealthy estates but is rapidly becoming a part of the maintenance of the average American home. Nurserymen who formerly propagated ornamentals for large-scale landscaping have found that the best market now is producing smaller plants suitable for the yard and house borders and gardens of the average householder. More and more homes are being planned with attention given to the outside decoration as well as to inside decoration. The

average home owner or tenant is now concerned with matters of disease and pests of ornamental and fruit-bearing plants. Secondly, state laws require nursery stock to be inspected annually before issuing the yearly license to protect the public, and these laws enforce special inspection of plants which require certification for interstate shipments. This service gives employment to those trained in practical biology. And thirdly, nursery inspection, because of its seasonal character, can be carried out by teachers and advanced students of biology employed on a temporary basis during school vacations. This convenient arrangement gives an additional supply of skilled personnel to the inspecting crews when the load is heaviest and gives seasonal employment to trained biologists when they might otherwise be idle.

Nearly all states have commerical nurseries varying from those with hundreds of acres of stock and doing business on a national scale to spare-time nurseries of a single man. The diseases and pests infesting the stock naturally vary with the region, climate, year, and kind of plants propagated. In Ohio, one of the leading producers of commercial plants, over 200 diseases and pests have been reported on nursery stock. Nearly half of these are of considerable importance. The diseases are caused by viruses, bacteria, and fungi. Most of the animal pests are insects, but occasionally they are nematods, sow bugs, red spiders (mites), or millipeds. Not only does the inspector prevent infested plants from being sold and scattered into new areas, but he assists the nurseryman in making plans for combating the diseases and pests to prevent their spread in the nursery. Some of the more common pests and diseases found by the writer on nursery plants while serving as a deputy inspector, selected to give a variety of both host plants and pests, will be mentioned here to serve as teaching material and as a guide to further study on the subject.

Some of the young peach trees were found infested with the peach tree borer and the peach twig borer. The first of these is the larval stage of a clear-winged moth. The eggs are laid on the bark of the trunk and the newly hatched larvae tunnel into the sapwood where they destroy the cambium, often girdling the young saplings, and in any case resulting in loss of sap and leaving the way open for other borers and fungus diseases. A gummy secretion near the ground betrays the presence of this borer. Young trees with this pest must usually be destroyed, especially if the cambium layer is girdled. The peach twig borer is an introduced moth from Europe and belongs to a different family from the preceding species. The larvae burrow into the shoots at springtime causing the buds to unfold and wither. In the summer they tunnel through both the twigs and fruit. Severe pruning is required to remove the pest.

On raspberry plants four common diseases were encountered. Two of them were caused by viruses—mosaic and leaf curl—while the others were crown gall, a bacterial disease, and orange rust, a fungus disease. All of these are of such a serious nature as to require the destruction of the infested plants.

Young elm trees were occasionally found to be attacked by the European elm scale, an insect which may kill the smaller trees and destroy the branches of larger ones. Also, honeydew secretions from the scales attract flies in great swarms. Spraying with full-strength dormant oil in early spring is the only effective control measure known

other than destroying badly injured trees. On lilac bushes the oyster-shell scale, another European introduction, was often abundant. Of all the scale insects found on Ohio nursery stock, this is the most difficult one to control. Destruction of the plants, especially when heavily coated with scales, is the only sure way of stopping the spread of this pest. Spraying with a miscible oil or nicotine sulphate while the young scales are in the "crawler" stage is helpful if attended to before the insect becomes too numerous. Another injurious insect of this shrub is the lilac borer, the larva of a clear-winged moth related to the peach tree borer. A sphecid wasp hunts out these borers for prey, and careful observation of these large wasps often leads to the discovery of borer infestations.

Pines of various species were subject to attack by the pine needle scale and the European pine shoot moth. The first of these forms a white crust of scales over the needles which is very conspicuous, often giving the foliage the appearance of being white-washed. Such large numbers may kill the trees. Spraying with dormant-strength lime-sulphur or oil is recommended. The larvae of the European pine shoot moth tunnel into the ends of the twigs causing resin to flow and destroying the buds. Thorough pruning of the infested twigs and spraying with lead arsenate and fish oil are necessary to prevent further spread. On spruce trees the eastern spruce gall aphid was the most frequently encountered pest. It was easily discovered by the presence of large thorny galls which it produces on the twigs. Pruning and spraying nicotine sulphate are the methods of treatment. On junipers, juniper webworm and juniper scale were the most important pests. The scales were often abundant, forming a grayish crust over the leaves from which they suck the juices of the plant. Dormant-strength lime-sulphur, the best spray, must be used before new plant growth begins in the spring. The webworm is found mostly in the Irish and Swedish types of junipers. Here the caterpillar binds the needles together with webbing in the thick foliage to form a tube in which it lives. Forceful spraying with lead arsenate to penetrate the silken nest with this stomach poison is necessary. Junipers with very heavy infestations of either scale or webworm should be destroyed. Varieties of yew, which have recently become some of the most popular ornamental evergreens, are attacked by the Taxus mealy bug. This insect forms puffy, silky masses in which they live among the inner layers of needles. Forceful spraying of a contact insecticide such as *Loro* is needed to break open the silky fibers and destroy the mealy bugs.

Gladioli are subject to a disease known as root rot caused by a soil fungus. It may also produce wilting of the plants without showing signs of rot. Such plants must be destroyed. Chrysanthemum plants were occasionally found serving as hosts to the Chrysanthemum midge or gall fly which forms galls in the flowers and leaves, and the European corn borer which bores into the stems. Contact sprays for the midge and pruning out stems containing the borer, which is the larval stage of a moth, are the control methods. When infestation is very severe, the plants should be destroyed.

While examining nurseries for diseases and pests, the inspectors are always on the alert to discover and report those enemies of plant life, such as the Japanese beetle, which are being investigated by the Federal Bureau of Entomology and Plant Quarantine.

This is another agency which is engaged in the application of biological knowledge to the control of pests which are detrimental to human welfare and offers another avenue for the employment of professional biologists.

The Morphological Mystagogue

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Fellow pedagogue, if you are one who may be of the opinion that there is no room in teaching for a bit of the thespian, then this is not for you. As good food is improved by spices, as a flower is made more desirable by its scent—so, too, is good teaching able to better impress and instill scientific fact by an occasional use of the dramatic.

The differences between Monocotyledoneae and Dicotyledoneae, subdivisions of the class Angiospermae, had been presented to my biology classes by the usual methods of text and reference readings, lecture and explanatory charts. A brief outline of the next day's class follows. In your writer's opinion, it transformed a bit of dry (to the average high school student) material into something vital, meaningful and most worthwhile.

"Come up here, Jerry. Thank you. Jerry, this is the magician's throne; and you are now KING OF THE MYSTICS. Take your throne, and if you promise to hold in your right hand this baton, the symbol of magic power, you shall be gifted immediately with a profound knowledge. In short, Jerry, yours is so great a gift that you can answer questions correctly, even though you think you do not know the answers."

"Jerry, how many petals are there on the flower of the Iris? Do you know the answer to that?"

"Well," said Jerry, "A neighbor of ours had some in her flower garden that were in bloom last, let's see now, June, I think it was. But, Gosh, I couldn't remember how many petals they had."

"You see, class, Jerry, the biology student, cannot answer the question put to him. But wait— I'll wager Jerry the Mystic can do it."

At this point the instructor takes from his desk a bottle containing a preserved Iris leaf and hands this to the student.

"Now, Oh mystic, examine this leaf of the Iris closely. While you do this, please be waving the magic baton over the bottle. Fine. Now the number of petals on the Iris can be found somewhere between one and one thousand. I shall give you but three chances, my mystic. Can you come through for us?"

Jerry mumbles something about paralleled veins, then says, "I have it now! It *must* be three, six or nine. No wonder you gave me three chances. From what I remember from the size of the flower, it is most likely nine."

"Nine is right, Jerry. One chance in a thousand and he bats a perfect score. Shall we try him again, class?"

A chorus of "Yes, yes" comes from the class.

"Make ready, mystic. On yonder North window is an African Violet in bloom. Can you tell us the number of petals on its flower?"

"I guess I'm stumped again—but could you let me see a leaf?"

"Surely. Betty, snip off a small leaf