FALL 1964

Frontiers

of PLANT SCIENCE

Dr. James B. Kring, left, explains aphid flight behavior to Jeffrey J. W. Baker, center, and Robert W. Martin, both of Wesleyan University, Middletown . . . see page 4.

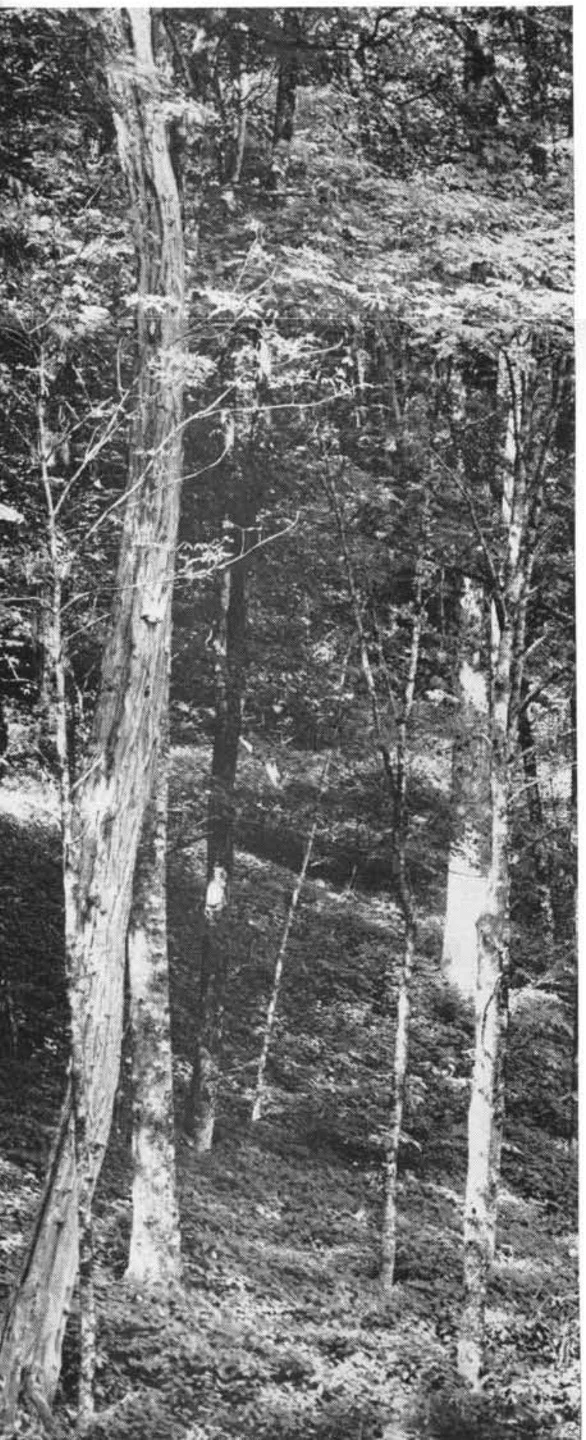
THE CONNECTICUT
AGRICULTURAL EXPERIMENT STATION
NEW HAVEN

WATER OR FOREST

CAN WE HAVE ALL WE NEED OF BOTH?

John D. Hewlett*

Through billions of tiny pores, or stomata, in leaves much of the million gallons of water an acre of forest may take up each year escapes as water vapor. Drawing above shows three stomata.



At six in the morning, the lingering mist rose from the narrow valley, revealing the tree-clad slopes of the Southern Appalachian mountains. The rotor from the resting helicopter stirred the leaves of nearby trees, as the pilot checked over a twenty-foot spraying boom attached to the underside of the ship. Then he gently lifted the flying spray gun into the cool morning air. His target was a nearby experimental watershed densely covered with forest trees. His purpose was to test a new way to increase water yield from our priceless mountain watersheds without damaging the trees and other living things.

MOST PEOPLE KNOW that water is becoming a major concern to our nation. Nearly everyone has heard of efforts to convert the salt sea to fresh water for man's use. But not everyone knows that the forest, which is the source and best protector of much of our water, is also one of nature's foremost water hogs. All plants need water to grow; the denser and larger the plants, the more water they pump from the soil and transpire into the air. To be sure, this water vapor is not truly lost forever, since it re-enters the cycling of moisture from oceans to continents, where it rains upon the earth and eventually returns down the rivers to the sea. However, the evaporation from the earth's oceans and the movement of vapor inland are so great that clouds do not need the moisture transpired by plants to produce normal local rainfall; thus, we think of water drunk up by plants as consumed or "lost" from further use by man.

One acre of forest land can drink up to a million gallons of water every year. In some water-hungry areas men have proposed to cut down all trees and shrubs to keep some of this water on the land, and to capture more of it in reservoirs and ground water. To the eternal danger of our forests, experiments have shown that this is indeed possible under certain conditions. For example, one watershed at Coweeta Hydrologic Laboratory, an experimental forest operated by the United States Forest Service in western North Carolina, began to yield an additional half million gallons per acre per year after careful felling of the forest. As the forest grew back, the stream grew smaller, and the leaves of the full grown trees were once again evaporating and transpiring more water than falls as total precipitation in many areas of the United States.

But must we fell the forest, and thus lose its many benefits, just to get more water? Is there no way to have our forest and extra water, too? Dr. Paul Waggoner, meteorologist with The Connecticut Agricultural Experiment Station, thinks there is. "You see," he says, "the water lost by trees passes out of the leaves through billions of tiny pores called stomata. These pores are complex little devices for letting carbon dioxide into the leaf for the manufacture of plant food, and at the same time letting oxygen and much water vapor out. The pores can open and shut, but they seem to stay open more than necessary to keep the plant growing. If we can find a chemical which will not harm the plant, but will cause these pores to close, we can let plants stand lush and even continue to grow somewhat without using so much water."

And, as it turns out, there are several harmless compounds which have been shown to reduce water loss by plants in small-scale experiments. Dr. Waggoner and his fellow scientists have been studying these chemicals for some time. Knowing of the Coweeta Hydrologic Laboratory and its

*Dr. Hewlett was Project Leader, the Coweeta Hydrologic Laboratory, U. S. Forest Service, Franklin, N. C., and is now Associate Professor of Forest Hydrology, University of Georgia, Athens.

An investigator compares loss of water by individual leaves before and after spraying with a transpiration inhibitor.

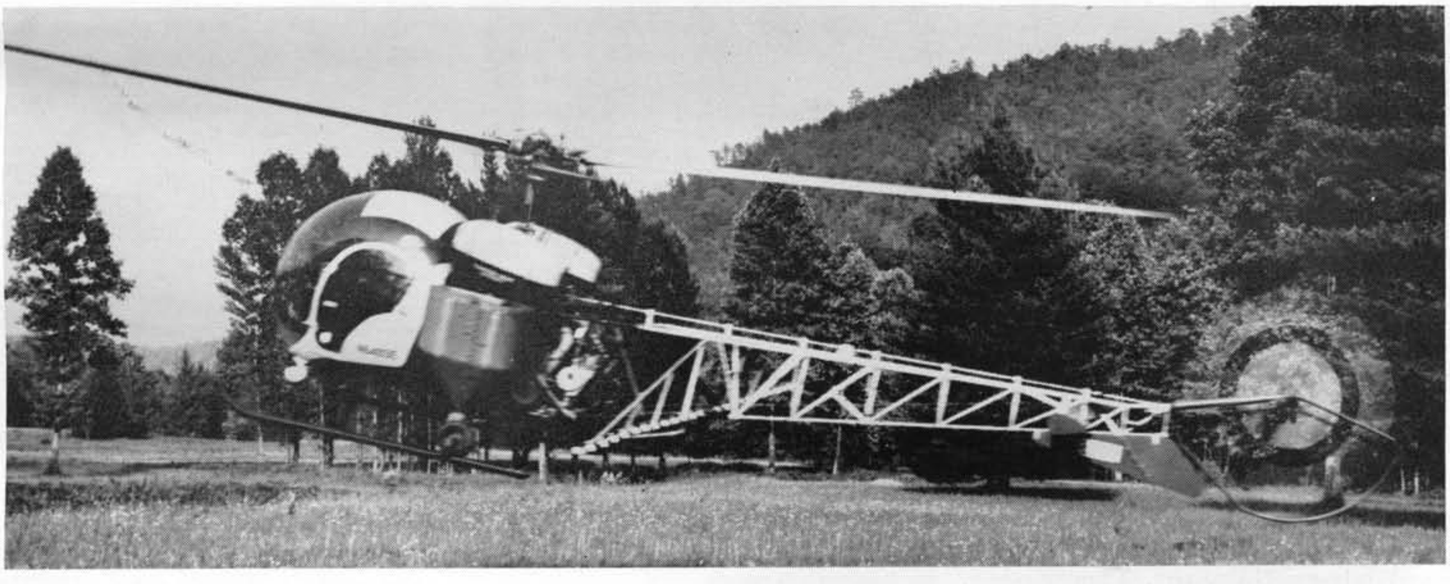
Thirty of these stream gauges, operated since 1934 by the Forest Service at the Coweeta Hydrologic Laboratory, enable scientists to measure water flow.

famous experimental watersheds, he proposed to me that the two experimental stations join forces in a full-scale test of this novel approach to water yield improvement. The plan was to spray the leaves of a forest area with one of the more effective chemicals and to determine through very accurate measurement of streamflow whether the watershed and its trees release more stream water during the following weeks and months.

Accordingly, the first large scale pilot test of a transpiration inhibitor was carried out during June 1964 by The Connecticut Agricultural Experiment Station and the U. S. Forest Service at Coweeta. The Connecticut Station provided the chemicals and the Forest Service provided the trees and watershed for the test. The watershed had to be equipped with rain and stream gauges, and also had to have many years of back records to serve as a base for measuring any change in water yield. A helicopter owned by the Tennessee Valley Authority was rented by the Connecticut Station for the job, and everyone waited for good weather to begin the test. Dr. Waggoner selected one of the more harmless chemicals—a form of decenylsuccinic acid—to mix with a large volume of water and then to spray in a fine mist at treetop level. We hoped that the spray would drift to the underside of the leaves where nearly all of the breathing pores are located. When the helicopter pilot reported fine spraying weather, the job was done in about one hour. Spray-sensitive cards on the ground and in the trees indicated that the 30-acre watershed had been well covered with drops of the spray, but that little had been delivered to the under surfaces of the leaves.

For the rest of the summer the research team anxiously watched the continuously recorded streamflow from the sprayed area to see if there was more water released to the stream gauge below. The results are not in yet; increases in streamflow brought about by reducing evaporation are not sudden and dramatic, but slow and steady. Such increases cannot fill up reservoirs overnight, but might tide over a drought period and help to prevent short, intense water famines from developing in cities and industries.

Whether or not this experiment succeeds, research to find ways to grow forests and crops on less water will continue. If plants can be made to produce the food, fiber, and wood we need on less water, perhaps new areas of water-scarce land can be opened to agriculture, and more fortunate areas with abundant rainfall may release extra water for uses in addition to wood production and agriculture. Dare we look to the day when we can have forests *and* more water, too?



Helicopter-applied spray of decenylsuccinic acid effectively covered upper surfaces of leaves in the 30-acre test plot, but little reached the underside of the leaves.

Getting Rid of Waste Water

Soil Survey Maps Are Used To Predict Success

David E. Hill
Soils and Climatology

THE EFFLUENT, or water discharged as waste from septic tanks, drains through the pore areas or inner space of the soil. Ideally, some soil types as classified by the soil surveyor differ in their inner space. The hardpan of the Wethersfield soil, for example, has only 25 per cent inner space while the Cheshire soil has fully 45 per cent at the same depth.

These soils and many others have been surveyed and mapped as part of a long-term program of this Station and the Soil Conservation Service. The maps have become widely used in predicting the success of a drainfield on any Connecticut acre.

Once a particular acre is chosen for development, a percolation test at that very site establishes the rate at which the soil will accept and transmit water. This seepage test is widely used in predicting the success of a drainfield on the tested site.

Our problem as soil scientists was to learn how accurately the results of percolation tests can be predicted from the classification units shown on our soil maps. To do this we measured percolation at sites that had the same soil type but were in different places, sometimes 10 miles apart. We also measured percolation in both wet and dry seasons.

The first question, therefore, was: "How much variability in percolation rates is there between sites and within sites whose soil is classified as the same type on standard survey maps?" To answer this question, standard percolation tests defined in the "Manual of Septic Tank Practice," U. S. Public Health Service Publication 526, were performed on three different soil types of Connecticut.

Wethersfield, one of the three, is a major soil formed on thousands of acres of compact, impermeable glacial deposit or till. Cheshire, also a major soil, was formed on friable, permeable glacial till. The third soil, Merrimac, is on sandy terraces that once bordered glacial lakes and streams. Three 36-inch deep test holes were examined at each site to evaluate the permeability of the substrata.

By superimposing the results of these tests performed on the three soils upon the soil permeability classes established in our state health codes, the range in variability of each soil type is revealed.

The compact Wethersfield soil has the least absolute variation. All but one of 12 test holes had percolation rates less than 2 inches an hour, a minimum rate established by the State Health Department as requiring special consideration to avoid nuisance conditions. The friable Cheshire soil varied considerably. No Cheshire test holes were in the "D" category prevalent on the Wethersfield soils. Thirteen of seventeen test holes, however, were either in the "C" or "B" category. The absolute variation was greatest in the Merrimac soil, but all test holes were in the "A" category.

Changes With Season

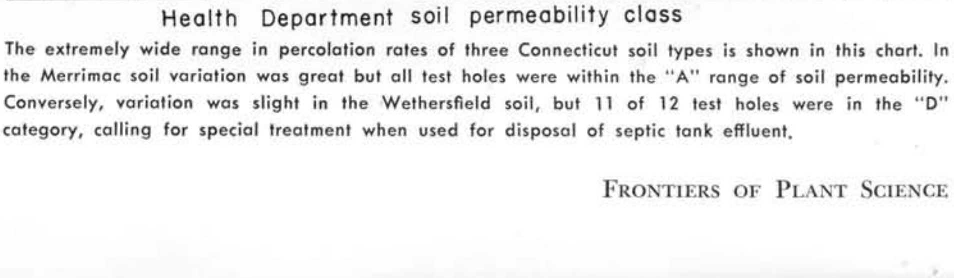
The second question was: "How much seasonal variation is there in percolation rates?" At sites representing each of the three soil types, percolation tests were repeated at different times of the year when the moisture contents of the soils were different. Although the seasonal changes varied among the soils, some generalities can be seen. In early spring, when the soils were wettest, the percolation rates were generally lowest. As the soil began to dry, the percolation rates increased. But the rates of many soils became slow again when the soil dried to great depths in late summer and early fall. At a high soil moisture content, the permeability rate is lowest because the moisture gradient is low —the surrounding soil is almost as wet as that bordering the test hole. As the soil dries the gradient steepens, and the water is transmitted more effectively. When the soil becomes still drier, resistance to moisture flow develops, and percolation slows.

Seasonal fluctuation in compact Wethersfield soil was small. This is of little concern in applying percolation data to septic tank performance because the rates are always too low and require special attention.

In the Cheshire soil, the rates change from one soil percolation class to another according to the season of measurement. Percolation rates measured during periods of low soil moisture could be optimistic when applied to waste disposal systems.

In the Merrimac soil, the seasonal percolation rates vary considerably but at rates so high that they would rarely cause problems in water transmission.

Applying soil survey studies to the prediction of septic tank performance, it is apparent that the permeability of many of our Connecticut soils varies in site and season from one to another of the soil percolation classes established in our health codes. Nevertheless, errors of prediction from soil surveys were found no more serious than variation of percolation tests within a site or between seasons. It is not surprising, therefore, that planners use the soil surveys more and more in anticipating how much inner space a site will have for water discharged as waste.



The extremely wide range in percolation rates of three Connecticut soil types is shown in this chart. In the Merrimac soil variation was great but all test holes were within the "A" range of soil permeability. Conversely, variation was slight in the Wethersfield soil, but 11 of 12 test holes were in the "D" category, calling for special treatment when used for disposal of septic tank effluent.

Cover Photo

Jeffrey J. W. Baker writes for *Current Science* and Robert W. Martin is biology editor of *Science and Math Weekly*, both published by the Department of School Services and Publications, Wesleyan University. They visited Lockwood Farm on Science at Work Day, August 12.

Antidote For Herbicides

Activated Carbon "Blots Them Up" When Unwanted

John F. Ahrens
Plant Pathology and Botany

THE VERY QUALITY of selectivity in herbicides may on occasion be a disadvantage. Farmers use atrazine in corn because it is selective—it kills weeds and does not damage the corn. If cabbage follows corn in the rotation, traces of atrazine in the soil will be troublesome. Similarly, if strawberries follow ornamental nursery stock in a field where simazine has been applied for several years, residues in the soil may interfere with growth.

The problem is to make selective herbicides even more selective by "turning them off" when they have done their job.

Sixteen years ago we faced a comparable problem in Connecticut. Growers needed a way to clear potato fields of benzene hexachloride, a selective insecticide. Scientists at this Station found that activated carbon applied to the soil adsorbed the insecticide and solved the growers' problem.

Herbicides Widely Used

At that time selective herbicides for commercial crops were few and little used. In recent years many highly selective herbicides have been developed. Among the most effective are those that act through plant roots to kill weeds in their early stages of growth. These herbicides, notably two of the triazine group called atrazine and simazine, are used to control weeds in thousands of acres of field and sweet corn, ornamental nurseries, and many other crops. A small amount of these triazine herbicides may persist in the soil for more than one season and injure non-tolerant crops that follow in the rotation.

We have found that activated charcoal can be used to inactivate residues of the triazine herbicides when non-tolerant crops are to be grown in these fields.

In our work on inactivation of residues we followed the lead of Gast, a researcher with the company manufacturing the triazines in Europe. He showed that activated carbon tied up herbicides just as it had tied up the benzene hexachloride insecticide in our potato fields. Experiments this year and last confirm his results under greenhouse and field conditions in Connecticut.

Initially we set out to determine how much activated carbon is required to inactivate a known level of herbicide in the soil. Known rates of simazine and atrazine were applied to soil and incorporated to simulate residues. Activated carbon was then applied and incorporated into the soil. Then we planted various indicator crops.

An amount of activated carbon approximately 200 times that of the herbicide residue protected seeded snap beans, and transplanted cabbage and tobacco planted immediately after treatment. Garden beets and oats, even more sensitive to triazine residues than beans, may require twice this amount of carbon for complete protection. Thorough mixing of the carbon into the soil containing the herbicide residue is essential for good results. The treatment was most effective in the field when the amount of simazine or atrazine was ¾ of a pound per acre or less. Fortunately this is about the range of residues left in the soil one year following applications of 2 to 3 pounds of simazine or atrazine to the acre.

Granular Forms Less Effective

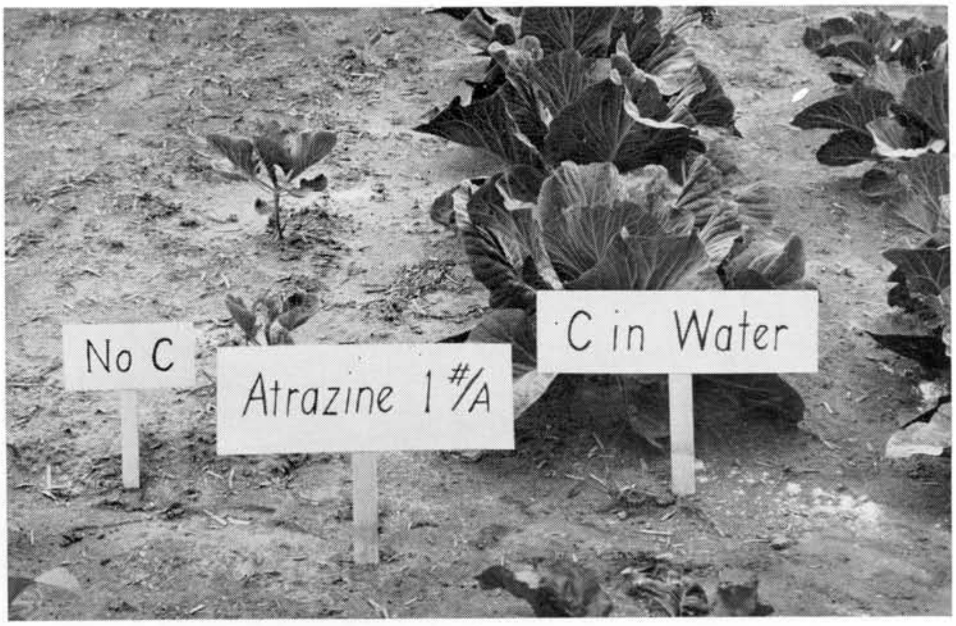
The carbon used in our work is a water purification grade called "Aqua Nuchar A," the same as that used to tie up the benzene hexachloride in potato fields in the late forties. Granular forms of activated carbon, with much less surface area, are not apt to be as effective. Finely divided activated carbon is dusty and dirty and dry applications are possible only in the still of the early morning or evening. However, spray applications with high gallonages and large nozzle tips now appear promising.

In experiments with other methods of applying carbon, we discovered that suspensions of carbon in the transplant water (½ to 1 pound in 6 gallons) prevented injury to cabbage and tobacco plants grown in soil containing residues of simazine or atrazine. Since many plants develop resistance to herbicides as they grow, such a "root zone" treatment can forestall or eliminate serious plant injury from herbicide residues. In our experiments root zone treatments were most effective in protecting transplanted cabbage and tobacco where atrazine residues were a half pound or less to the acre. Root zone treatments in transplant water greatly reduce the amount of carbon required per acre and they are easily applied.

Dipping Roots Suffices

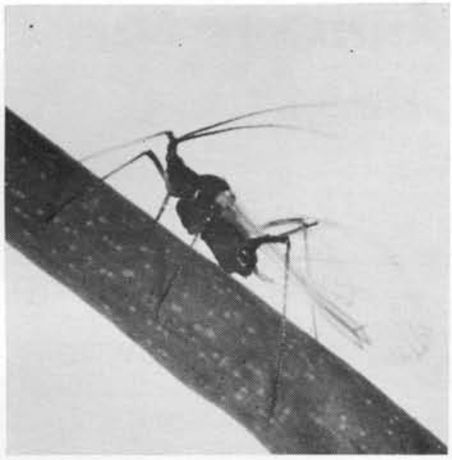
The transplant water method can provide protection to marginally sensitive plants from post-planting applications of herbicides. We also found, however, that merely dipping the roots of strawberry plants, forsythia, and privet cuttings into activated carbon before transplanting reduced or eliminated injury from applications of simazine after planting. Since activated carbon also adsorbs other herbicides, treatments of this type should improve selective applications of herbicides in general. For example, by including activated carbon in the sand-peat media surrounding chestnuts in a field planting, we have protected them from the herbicide diphenamid.

(Continued on page 7)



With atrazine residue in the soil at the rate of 1 pound per acre, cabbage plants thrive at right where activated carbon has been applied, fail at left where there is no carbon.

In Connecticut we have more than 200 different kinds of aphids, small sucking insects that feed on plants. Many of them overwinter as eggs on the bark and branches of trees and bushes. The individuals that hatch from these eggs in April and May begin to feed and reproduce. All are females, and they give birth to living young. When these young are born their own female offspring are already partly developed. Under favorable conditions of dry, warm weather, these newly born aphids may produce young in as short a period as three days. Some are winged, and these fly to other plants to start new colonies. Aphids may be able to live and produce colonies on many kinds of plants, or on only one kind. In the fall males and females develop, meet on the winter host, and produce the over-wintering eggs. This assures us of aphids next year.



Macrosiphum rosae, one of the more than 200 different kinds of aphids in Connecticut.

NEW WAYS TO REPEL APHIDS

James B. Kring
Entomology

MAN IN HIS DESIRE to free himself of earthen bonds has long directed his attention to flying animals. He has questioned the how, the where to and from, and the why of their flights. The pursuit of answers to each of these questions has opened up new vistas of wonder.

History records our failure to imitate the flight of other animals. Now finally we have successfully developed machines that not only take us through the areas where other animals fly but also permit us to pass far beyond these limits.

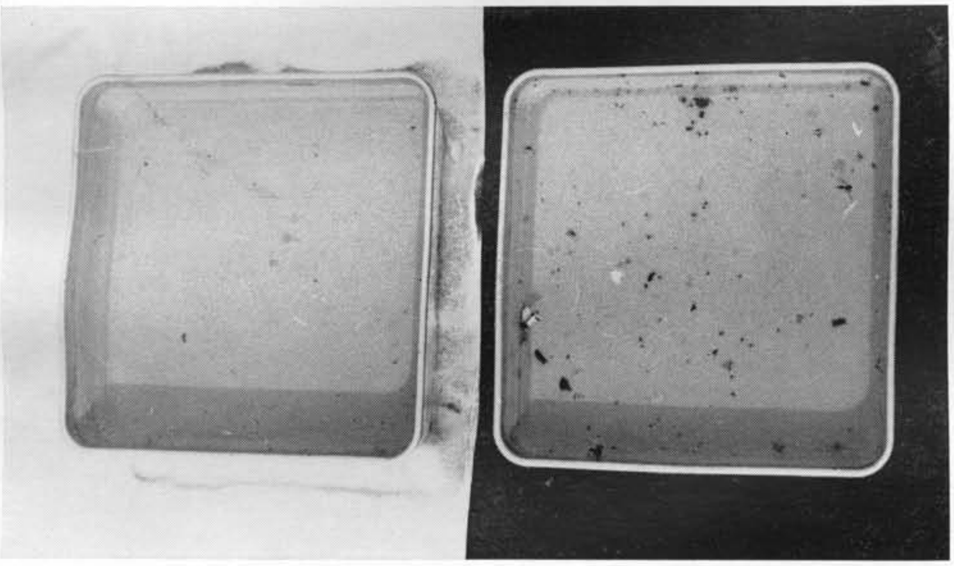
Many of us who are not privileged to be a part of this effort are left here on earth to face the problems created by creatures of flight.

One group of flying animals, the aphids, are of particular interest because they compete with us for food. These insects spread from plant to plant primarily by flying. In so doing they may spread virus diseases from plant to plant after they alight and feed or attempt to feed. Damage to the plants, either by the feeding or by the transmitted virus, may be severe.

Infestation of plants and spread of aphid-borne virus from one plant to another could be stopped if aphids could be prevented from alighting in a crop.

This possibility has intrigued me for a number of years. Studying the work of many students of aphid flight and watching aphids themselves suggested a method.

Shallow cake pans painted yellow and filled with water are used by many workers as traps to capture aphids. The aphids are attracted by the yellow color and alight on the water surface. A small amount of detergent in the water changes the surface tension and traps these insects, preventing them from taking off again.



How changing the background of trap pans affects aphid behavior: at left, aluminum surface repels aphids; at right, many aphids and other insects are attracted by the yellow pan on bare soil. Pans were placed close together after insects had alighted.

Winged aphids fly towards the open sky when they first take off from their host plant. When they are ready to alight they fly away from the open sky. At this stage of their flight they are reported to be actually repelled by the light from the sky. If this be true, an alighting aphid presented with two "skies" might be confused and so not alight on plants where protection is desired.

ALUMINUM KEEPS APHIDS AWAY

Aluminum placed on the soil reflects much of the light from the sky and so presents the aphid with two skies. Aphids do not alight in the yellow colored cake pans when they are closely surrounded by aluminum cake pans. The efficiency of this method of repelling aphids depends on how much of the surrounding area is covered by aluminum. By moving the aluminum pans farther away from the trap or using fewer pans, the trap again catches aphids. Substituting aluminum surfaced sheets for the unpainted pans has the same effect.

Yellow traps surrounded by bare soil catch more aphids than the same traps surrounded by aluminum. Thus the background alters the attractiveness of the trap.

Two types of flight are observed near the pans. Some of the aphids entering the area begin a bobbing flight that gradually carries them from the area. This is the expected reaction of the insect to the light of the sky reflected up from the ground. Other aphids veer away. In other animals this veering is referred to as the dorsal light reaction. The insect essentially changes the position of its body to adjust to the two sources of light and changes the direction of its flight.

Since the aluminum surfaces can also reflect heat which may be un-

Aluminum strips provide a zone of protection against aphids, causing them to fly away from the normally attractive yellow trap pan.

desirable for some plants, I looked for another way to change the background. A method was suggested when I found that yellow pan traps placed among plots of cabbages and nasturtiums caught somewhat similar numbers of aphids, until the nasturtiums began to bloom. Then fewer aphids were captured among the nasturtiums than among the cabbages. This suggested that the orange color of the nasturtium flowers repelled the aphids.

To simulate the effect of the color of the flowers the trap pan was placed on a background as similar in color to the flowers as possible—orange-colored plastic shower curtains and plastics used to upholster lawn furniture. Shiny black plastic commonly used for mulching was compared to these orange-colored plastics and to the aluminum coated materials for its effect on the efficiency of the trap. I found that all of these background materials drastically reduced the numbers of aphids captured by the traps. The aluminum was most effective, followed closely by the orange materials and the shiny black plastic.

Practical Uses Being Tested

As one might expect, I then found that plants surrounded by aluminum, by orange-colored plastic, and to a lesser extent by shining black plastic were protected from attack by aphids.

These results suggest many practical applications. It seems conclusive that by simply altering the reflectance and the color of the background of plants we can induce flying aphids to move along and leave our crop plants unmolested.

In a talk before the Entomological Society of America in 1962, I reported my results with aluminum and said that reflection might be used in practice to protect plants from aphid attack. Researchers in the U. S. Department of Agriculture and elsewhere using aluminum in various ways are now testing this method further.

IN THE NEWS

Dr. A. E. Dimond, chief of the Department of Plant Pathology and Botany, completed his term as president of the American Phytopathological Society in August. He is the third Connecticut Station plant pathologist to head the 56-year-old society.

Receives Honorary Doctorate

The University of Turin conferred the honorary doctorate on Dr. James G. Horsfall, director of the Station, on November 5. On his return from Italy Dr. Horsfall left for Argentina where he is conferring with plant pathologists and others concerned with research.

Most Feeds Meet Guarantees

Connecticut farmers have spent about $40 million a year in recent years on feed, their largest single item of operating expense. To help safeguard the quality of this feed, the Station takes some 700 official samples from stocks offered for sale and publishes the results of analyses of the samples. The most recent report shows that 93 per cent of the official samples met all guarantees made for them by manufacturers.

Honored For Long Service

Three active staff members and one who has retired were honored in October in completion of a quarter century of service.

Dr. Edmund W. Sinnott, secretary of the Board of Control, presented scrolls to Director James G. Horsfall, Raimon L. Beard, and R. Richard Nichols. Sylvio J. Deaume, retired after service in plant pest control since 1939, was unable to attend. Neely Turner, vice director of the Station, presided at the recognition ceremony.

Dr. Beard has long been expected to find useful answers to some of the most perplexing problems in his field of entomology. And he has done so, as evidenced by his publications and the esteem in which he is held by his fellow scientists.

Speaking of Dr. Horsfall, a plant pathologist who became director of the Station in 1948, Mr. Turner said: "It is achievement in science that brings him honors and invitations to speak here and abroad. His abilities as an administrator are also recognized widely, as attested by invitations to participate in determining the future course of scientific research."

Mr. Nichols is sampling agent for the Station. He probes into bags of feed and fertilizers and pesticides for official samples later analyzed by Station chemists. He is also custodian of Station publications and in charge of the mailing room. Station publications are regularly sent on request to thousands of individuals and several hundred libraries throughout the world. Mr. Nichols starts them on the way.

New Staff Members

Five scientists have been appointed to the Station staff since publication of the Spring Issue of FRONTIERS.

Dr. Pappachan E. Kolattukudy is investigating the biochemistry of the synthesis of the cuticle of leaves. Little is known about how plant cells put together the waxes and hydrocarbons that cover leaves and so are important in water relations and in disease resistance.

Dr. Ronald J. Prokopy, an entomologist, is working on the control of apple maggots by use of baits and other methods rather than by conventional spraying. He is also studying integration of all known methods of controlling apple insects and mites.

In the Department of Plant Pathology and Botany, Dr. Sven E. Wihrheim is investigating the stimulated hatching of eggs of the tobacco cyst nematode by fungicides and other compounds. He is working with Dr. Patrick M. Miller of the Station, who discovered several years ago that certain fungicides stimulate the hatching of nematode eggs.

In the field of ecology, Dr. Keith Loach is continuing the research reported in the Spring Issue of FRONTIERS by Dr. J. Phillip Grime. Dr. Loach will look into ways to gain a measure of control over succession in fields and woodlands where the reversion to forest is no longer controlled by tillage, cutting, and grazing.

Dr. Evelyn A. Havir began work in the Department of Biochemistry on November 2. She is studying biochemical reactions related to the synthesis of certain phenolic compounds in plants. These phenolic compounds are believed to be associated with the control of respiration, flowering, and other life processes in plants.

Antidote For Herbicides

(Continued from page 5)

The action of activated carbon in protecting plants from herbicides is envisioned as simple adsorption. The charged carbon particles hold the herbicide so tightly that plant roots cannot take it up.

Studies with activated carbon and herbicides continue, for there are many questions left unanswered. Results obtained thus far, however, show that activated carbon is an effective antidote for herbicides in soils, thereby making these useful materials even more selective.

From the Director

James G. Horsfall

THE STATION was selected last summer by the National Park Service as a National Historic Landmark. I paraphrase Kingman Brewster, Jr., newly inaugurated president of Yale, when I say that it is not our part to thank the Park Service for selecting us as a National Historic Landmark. Our response is rather that of privilege so touched with awe that gratitude is not its primary character. We do hope and pray that we may continue to warrant the privilege.

We trust that we may continue to serve the citizens of Connecticut through science that is important, not just novel. Some scientists at some institutions feel that the significance of their research is inversely proportional to its social importance, that is if it can be used, it is not good science. Many botanists, for example, would rather work with the duckweed that floats on a stagnant pool than with corn that grows on the fields above. Often the effort to avoid the socially important, results in science that is trivial. We hope we do not succumb to that siren song.

Sometimes duckweed will tell us something about corn. Dr. Israel Zelitch's important discovery on stomata was made with tobacco. His discovery was important to science because it produced a big advance in our knowledge of these portals in the leaf that open and close to regulate the ingress and egress of water, oxygen, and carbon dioxide. It was also important to fundamental biology. Plants remove carbon dioxide from the air and replace it with oxygen via the stomatal pathway. In the process, the plants synthesize sugars and proteins for their body stuff. Stomatal research is basic research, basic research in the processes of life.

Zelitch's discovery was as important to society as it was to science because understanding the stomata is basic to understanding how plants perform their share of nature's never ending cycle from soil and air to plants, to animals, and back to soil and air.

With added understanding we can gain better control of nature, and it is our job to show how this can be done.

The Long Leap

As every investigator knows, the leap from the laboratory bench to the open field can be a long one, however. Many promising materials and bright ideas have disappeared into the chasm between what is possible and what is practical. We set out to bridge the chasm.

Zelitch and Dr. Paul E. Waggoner of this Station believed that crop plants or a stand of trees might be made to transpire or evaporate less water by closing the pores of the leaves. The idea made sense, and it checked out in laboratory and greenhouse experiments. Waggoner made a field test on barley. He showed that a chemical sprayed on the plants reduced the amount of water evaporated and did not proportionately reduce photosynthesis and growth of the barley plants.

Another field test on a wooded watershed in North Carolina was inconclusive (see page 2), but results on lawns and tobacco and corn look promising.

There are other implications, too, in this research on the portals of leaves. The leaf stomata may also admit a toxic gas to the leaf. This gas is ozone, an increasingly troublesome air pollutant from automobiles that damages plants in and near cities. To use Zelitch's method of closing the stomates on crop plants for a few hours holds promise of reducing damage by ozone. Thus, we continue to follow our historical dictum HOW CROPS GROW so that Connecticut may know HOW TO GROW CROPS. We think that such research befits a lively National Landmark.

New Publications

The publications below have been issued by the Station since you last received FRONTIERS. Address requests for copies to Publications, The Connecticut Agricultural Experiment Station, Box 1106, New Haven, Connecticut 06504.

Biochemistry

B 664 *Stomata and Water Relations in Plants.* (Papers and discussions given July 1 to 12, 1963 as part of the Advanced Science Seminar on the Physiology and Biochemistry of Leaf Stomata.) Edited by Israel Zelitch.

Entomology

Special Circular. *The European Chafer.* Neely Turner.

Report on Inspection

B 667 *Commercial Feeding Stuffs, 1963.* H. J. Fisher.

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James G. Horsfall
Director

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