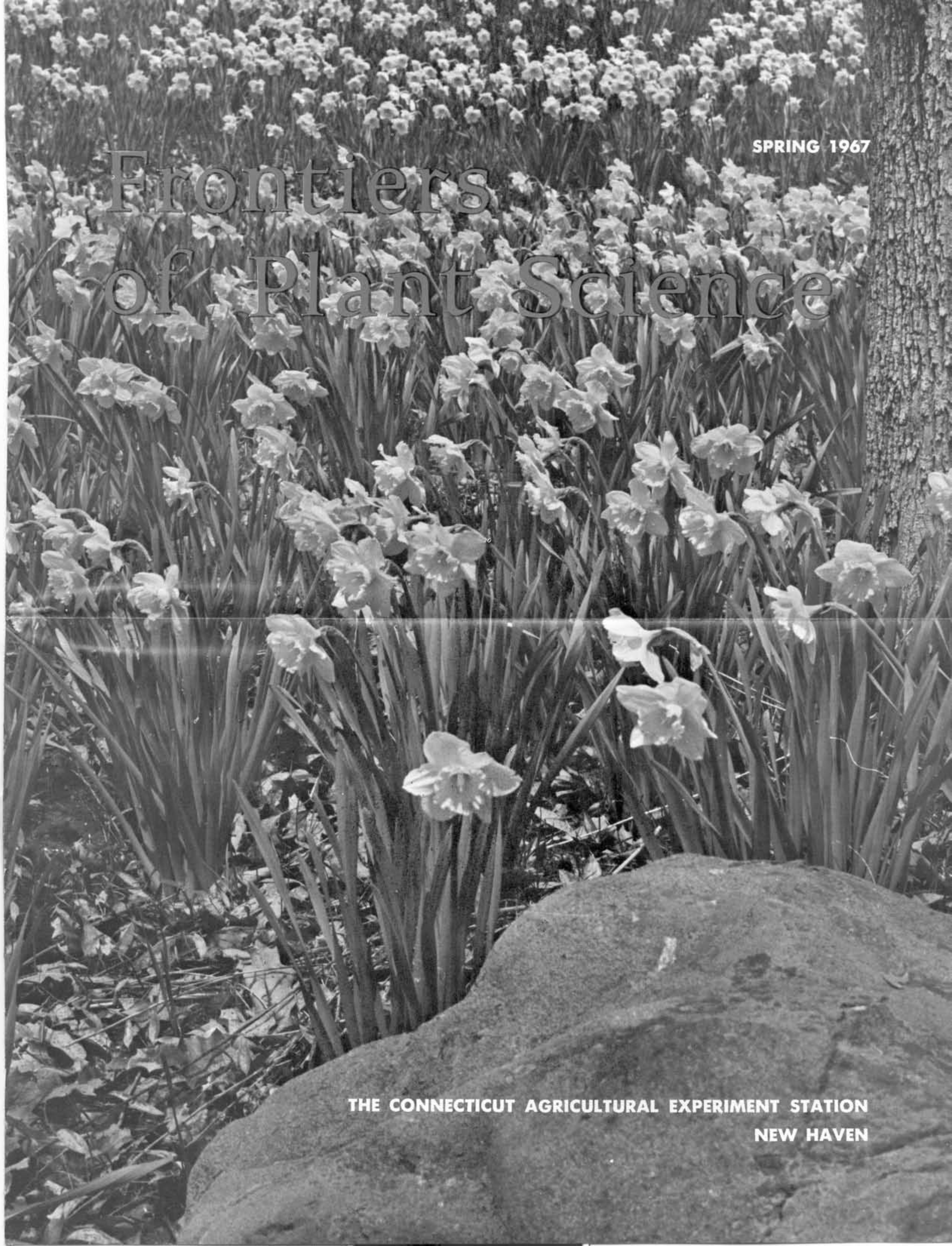
SPRING 1967

Frontiers of Plant Science



THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION
NEW HAVEN

A Layman's View of Research

Percy Maxim Lee

I AM AWARE of the unique and distinguished service this institution has offered the state and the public throughout its years of activity and the hope underlying my remarks today is that its future will be even greater than its past. The potential exists; continued enlightened management programming and support will make it a reality.

Now, I am a great admirer of research institutions and researchers, especially of men like the late Dr. Kettering of General Motors whom I quote every time I get a chance. "Be careful about logic," he warned his young engineers, "for logic is an organized way of going wrong with confidence."

There is another distinguished administrator-scientist for whom I have the most profound regard and from whom I would like to quote. He has recently completed a study which explores methods for increasing originality and innovation in research laboratories and examines ways to develop more effective use of the originality which already exists.

The summary states in part and I quote: "The usual pattern of a technology as it evolves from the pioneering stage to maturity is for originality or innovation to become less and less prominent. In final stages of the aging process, innovation almost entirely disappears. Originality may be defined as the combination of insight, curiosity and uninhibited thought which causes the unexpected to become apparent. Innovation is that combination of originality and creative drive which causes the unexpected to actually occur."

He goes on to say: "Organization is almost always the enemy of originality. Expensive and sophisticated equipment requires orderly management. Unless management at all levels is continuously alert, order will crowd out innovation and old age will set in."

"What are the fundamentals which are required for originality to flourish?" he asks. "The greatest of these is change. Creativity does not prosper under constant conditions, no matter how beneficial the static arrangements. Lively fish are found in running streams, not in stagnant ponds. Since labs are and must remain essentially stable, if not fixed institutions, change can best be produced by what flows through them. Therefore, essential to continued creativity and originality is a continuous flow of new men and women, new ideas and new problems. An establishment will age rapidly if promising new people are not brought in or if they are not in communication with stimulating ideas or if the problems on which they are working are not something more than refinements of old problems."

In many respects, I would say, the Station is in a preferred position. Men, ideas and problems flow continuously. Management has been alert and old age has not set in. The record of achievement is distinguished.

I would like to point out that one of the important ingredients that is essential to most progress in a democratic society is produced by the needling citizen. The Rachel Carsons and Ralph Naders may seem to be irresponsible irritants to producers and scientists, as indeed are those who bitterly oppose various utility activities along the Connecticut River, but these people *do* perform an invaluable service for the rest of us. In the process of having to justify what *is*, what *might be* is seen; sometimes through a glass darkly! In addition, invention, like reform, usually follows the disclosure of a *need*. While I am aware that a mere layman should never even hint at what a research lab should do, the layman is, after all, the one benefitted or victimized by the extension of knowledge and his protests or wishes, though based on ignorance, may open up new avenues to the alert researcher.

Perhaps I might reveal some wishes of my own.

1. I wish raspberries were not so perishable.

2. I wish there was something more useful that developers and construction people could do with all the trees and brush they cut except just burning them.

3. I wish the masses of eel grass growing along the Connecticut coast could be controlled and put to some useful purpose.

4. I wish a drought- and disease-resistant, slow growing, inexpensive and evergreen lawn grass were available.

5. I wish Connecticut would lead the nation in environmental pollution control and in natural resource management.

6. And I wish Connecticut would develop the country's most effective commodity testing service for the benefit of consumers.

I would like to elaborate a little on the last two points. I had the privilege of serving on President Kennedy's Consumer Advisory Council and for a short time in filling out my term was appointed by President Johnson as chairman of the Council. President Kennedy's enumeration of the four basic rights of the consumer are worth repeating: the right to safety, the right to be informed, the right to choose, the right to be heard. The basic principle involved here is that American consumers have a right to all the information necessary to perform their economic function as buyers efficiently. The function of this Station lies largely in underwriting the first two rights: the right to safety and the right to be informed.

Connecticut, I believe, has the only Department of Consumer Protection at the Governor's Cabinet level in the country. This has been an effective department within the limits of its funds and manpower.

"Organization is almost always the enemy of originality"

The extension of the services of this Station to further buttress the aims of the Department seems quite in order.

The confused consumer needs help. He needs to be provided with accurate and reliable information in order to make informed judgments. He often needs to know in a hurry, or thinks he does.

Above all, he needs to have confidence in the source of his information. The question of credibility should never occur.

This leads me to my second point: Connecticut's responsibility in regard to the elimination of much of our environmental pollution, and the need for increasingly effective natural resource management. I call your attention to the recommendations of Connecticut's Clean Water Task Force whose report was submitted to Governor Dempsey in May. While the state's responsibility is far broader than concern for water alone, this is indeed an issue which demands emergency action.

While I have been told by the experts that no scientific breakthroughs are anticipated, I reject the notion that this Station and other research agencies will not come up with new ideas and new technical advances which will enable the costs to be cut and the programs to become more effective. The Station has set an enormously intriguing example by its work in regard to the control of the transpiration of plants and trees and its effect upon ground water. Where man is concerned apparently *nothing* is impossible.

While I believe that the Station should extend its services to the Department of Agriculture and Natural Resources and Consumer Protection, I am conscious of still another area of activity of vast importance. I realize that the Station is a nice blend of pure and applied research and that chemical analysis of agricultural products is its origin. And now, given the world we live in, I've wondered whether the Station could be of even more specific assistance to local governments and regional planning agencies. This would provide an opportunity to come into direct contact with the consumer where he lives—where he uses air and water and land and products. It is here where he is beset with conflicting desires and ideals and necessities. Is it reasonable to suggest that as a regional plan develops or a community Conservation Commission lays out a course of action that the Station be asked to provide all pertinent scientific information on the ecological effects of the propositions? It occurs to me that if this sort of work were undertaken it could lead to what I believe the research people call "input," that is the introduction of new areas for either applied or pure research.

The longer I live the more conscious and alarmed I become about the proliferation and fragmentation of knowledge on the one hand and the interdependence of all life on the other hand. Scientific and technological advances are such that the specialist can hardly keep abreast of his own rapidly extending and changing field, much less does he have time to share in other developments. The interdependence and inter-relationship of life and living is not always sufficiently considered. Modern society does not develop as a balanced whole nor is it viewed as such. But greater efforts should be made to this end.

I am sure there is some sort of moral which can be applied here in the old couplet which goes this way:

"The crane which waited for the sea to sink
And leave dried fish to feed him, died, I think."

Contributors

Percy Maxim Lee, former president of the League of Women Voters in this state and in the nation, is widely known for her leadership in diverse matters of public concern. "A Layman's View" is an abridgement of the address Mrs. Lee gave during Science At Work Day in 1966.

Dr. Raymond J. Lukens, a plant pathologist, conducts research on the mode of action of fungicides in controlled environments and in the field.

Dr. Ronald J. Prokopy, who became a member of the Station staff in entomology in 1964, is investigating approaches to biological control of insects and other pests of apples.

Science At Work August 9, Mt. Carmel

Dr. Ivan L. Bennett, Jr.

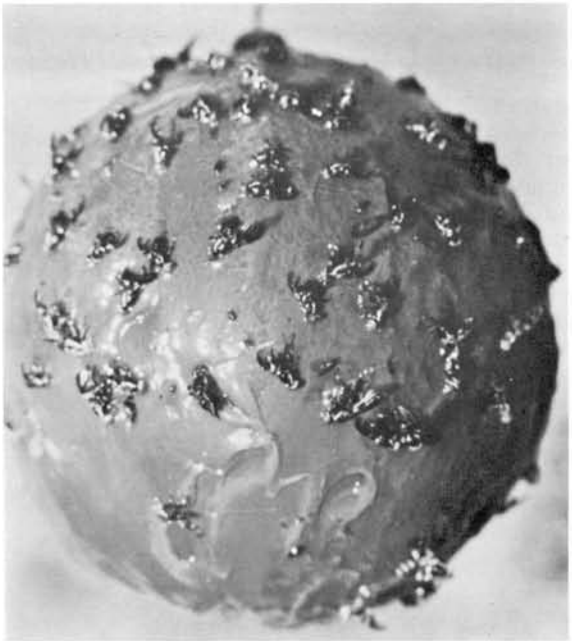
Dr. Ivan L. Bennett, Jr., will deliver the Samuel W. Johnson Memorial Lecture on the Science At Work program to be presented at Lockwood Farm in Mt. Carmel on Wednesday, August 9. Dr. Bennett is deputy director of the Office of Science and Technology in the Executive Office of the President.

After two years as assistant professor at Yale, Dr. Bennett became associate professor and, in 1957, professor of medicine and head of the Division of Biology and Oncology at Johns Hopkins. A year later he was named director of the Department of Pathology in the University School of Medicine and pathologist-in-chief of the Johns Hopkins Hospital.

He is a member of the Board of Scientific Advisors of the Armed Forces Institute of Pathology, the National Board of Medical Examiners, and the Executive Committee of the Division of Medical Sciences of the National Research Council.

Dr. Bennett will speak at 1 p.m. The program of talks, discussions, and inspection of research plots will begin at 9:30 in the morning, continuing to 4 p.m. For the convenience of those who cannot attend earlier, a part of the program will be repeated from 5 to 8 p.m. All are invited.

Dr. Lester Hankin of the Station Department of Biochemistry is general chairman for Science at Work.



Apple maggot flies (above) insert eggs into apples from late June until harvest. Activity of flies in the orchard may be estimated by attracting them to colored spheres with a sticky surface (left).

Wooden "Apples" Lure Costly Pest

Ronald J. Prokopy

THE FIRST APPLES ever to grow in this country were planted by one of the Pilgrims about 350 years ago. Since that time apples have become one of our favorite fresh fruits. To our dismay, however, they have also become food for nearly 500 different species of insects.

Perhaps the most destructive of these insects in Connecticut is one known as the apple maggot or railroad worm. This particular insect is annoying not only because of the great regularity with which it attacks unprotected apples but also because of the subtle, almost concealed evidence of its injury.

The activities of the apple maggot begin in late June, when the maggot flies emerge from the overwintering puparia or cocoons. The flies feed on the surface of leaves for a week or two and then the females begin inserting eggs into the apples. Tiny larvae, or maggots, hatch from the eggs and start to burrow their way through the flesh of the apple, leaving brown trails or tunnels in their wake. Except for the rather inconspicuous punctures made from egg laying, an apple may appear from the exterior to be in almost perfect condition and yet be riddled inside with these maggot tunnels.

At present, the only effective method we have for protecting our apples from this highly destructive pest is to kill the maggot flies with insecticide before they have had a chance to lay any eggs. There are at least three important disadvantages of this method.

First, the method is expensive. Adequate control requires application at least every 10 to 14 days beginning in late June. Second, care must be taken to insure that no excessive residues of insecticides appear on the fruit at harvest. This is a continual problem. Maggot flies are capable of laying eggs right up through harvest, and the grower faces the predicament of either spraying close to harvest and thereby risking excessive residues or not spraying and thereby risking apple maggot injury. Third, those insecticides which kill maggot flies are also highly toxic to many beneficial predators and parasites of other apple pests. Further, they can be toxic to the applicator if he is not sufficiently protected.

Here at the Experiment Station we are investigating a new approach toward controlling the apple maggot. This approach is centered around the attraction of the maggot flies in nature to a chemical sterilant. It had its origin about 30 years ago when Dr. E. F. Knipling, an imaginative entomologist with the U. S. Department of Agriculture, conceived of the possibility of completely eliminating a natural population of insects by sterilizing the males. His reasoning was based on the biological fact that the eggs of most insects, among them the apple maggot, will not hatch unless fertilized by the sperm of the male. Should the proportion of sterile to fertile males continually increase with time, the population would eventually become extinct.

Within the past decade a group of chemicals have been discovered which, when ingested by certain insects, cause sterility. Early indications are that the apple maggot may be one of these insects. None of the chemical sterilants has proven to be specific against only one species of animal to the exclusion of all others, however. Were they to be used for apple maggot elimination, they could not, therefore, simply be broadcast throughout an apple orchard or other locality without the risk of causing sterility of all sorts of beneficial animals. Their distribution would have to be limited to a number of specific sites, and some method would have to be found for attracting large numbers of apple maggot flies, and only apple maggot flies, to these sites.

Although our knowledge of the whys and wherefores of insect attraction is still grossly inadequate for our special purposes, we do know that close relatives of apple maggot flies have a particularly acute sense of smell. In all probability, therefore, the attraction of a sufficiently large proportion of the maggot fly population to the chemical sterilant will depend ultimately on the discovery and use of a highly attractive odor. However, once attracted by odor to the general vicinity of the sterilant, the flies may require use of other senses, such as vision, for ready identification of the exact site of the sterilant.

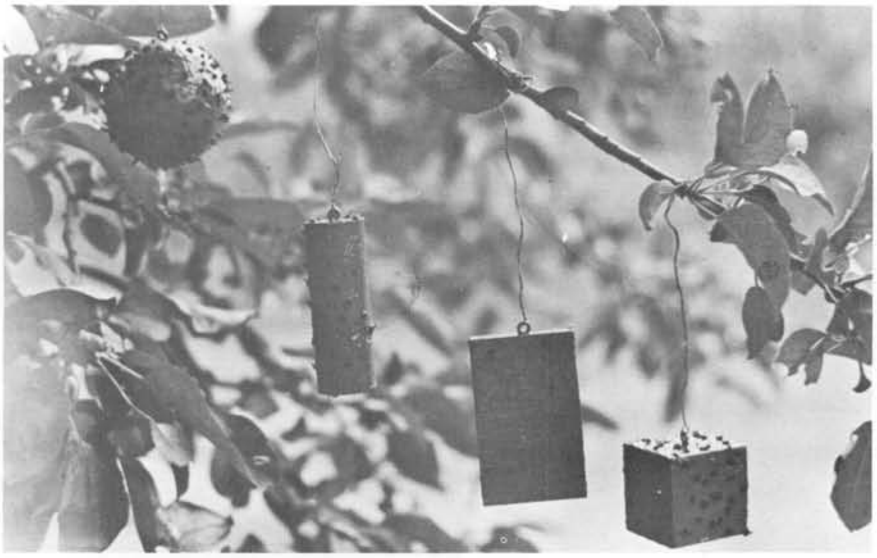
During the past two years I have been investigating visual responses of apple maggot flies. I began by testing their response to color and found that when flies in the laboratory were allowed to choose among artificial apples of different colors, they laid the most eggs in blue or red apples, an intermediate number in green or orange, and fewest of all in yellow.

Then I tested the response of flies in an apple orchard to these same colors, only this time I wasn't interested in egg-laying but rather in the number of flies that flew to each color. In place of artificial apples, I used colored spheres—croquet balls —and large, colored rectangles and suspended them about two feet away from the trees. The spheres and rectangles were coated with a sticky substance to catch and hold the flies.

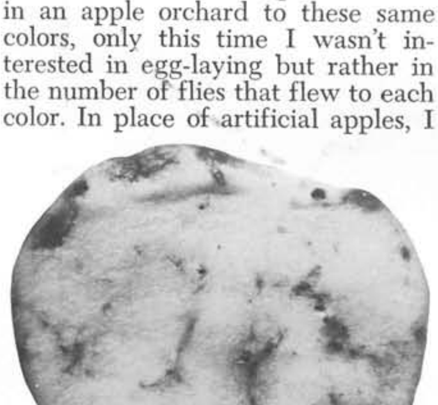
The results were most curious. The order of color preference for the spheres was virtually the same as for the artificial apples, but for the rectangles was just the opposite. The most maggot flies were caught on the yellow rectangles, an intermediate number on the green or orange, and fewest of all on the blue or red. Of equal interest was the fact that a much greater number of maggot flies was caught on the spheres than on the rectangles even though the spheres were much smaller than the rectangles. Thus, the flies exhibited a distinct response to shape as well as to color. In a further experiment, I found that when sticky-coated objects of four different shapes, all of equal surface area, were hung from the branches of apple trees, maggot flies were much more highly attracted to spheres than to cubes, cylinders, or rectangles.

Considerable experimentation remains before these findings can be explained with certainty. In the realm of speculation, however, it seems possible that the reason why the flies were more attracted to large rectangles of yellow color was that the flies saw the yellow rectangles, as perhaps they would see any other large mass of yellow, as foliage on which to feed. Perhaps the flies were much more highly attracted to the spheres than to any other object tested because of the close resemblance of the shape of the spheres to that of apples. This would suggest that the flies detect an apple at least partly on the basis of its shape. If this were true, then those particular apples or spheres whose shapes were most sharply outlined against the background may have been the most easily perceived. The greater attraction of the flies to blue and red artificial apples and spheres may therefore have been less a response to blue and red as colors than to the fact that these apples and spheres may have been more readily distinguishable from the background than the yellow, green, and orange apples and spheres.

We still do not know which shape and color when combined with attractive odor would lure the most maggot flies to a chemical sterilant. The answer to that question, however, is not the only benefit anticipated from our investigation. One side-benefit is that blue or red croquet balls coated with a sticky substance (such as tanglefoot) and hung from apple tree branches should provide commercial and backyard growers a good means for estimating seasonal trends in maggot fly activity. The balls by themselves would probably not be effective in controlling the apple maggot but should be a valuable aid in the proper timing of protective sprays.

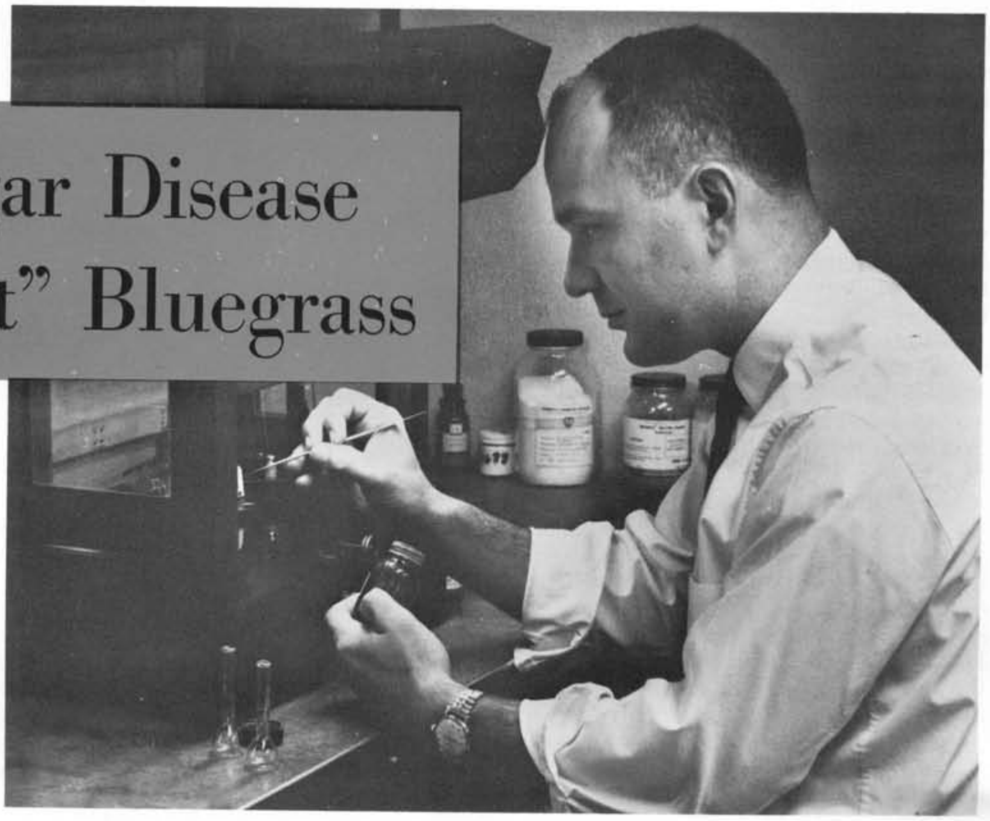


Maggot flies were much more highly attracted to spheres, as at the left, than to cubes, cylinders, or rectangles. In field experiments, objects were about six feet apart.



Misshapen apple, cut open, shows damage from apple maggot larvae.

Low-Sugar Disease "Melts Out" Bluegrass



Dr. Raymond J. Lukens

Raymond J. Lukens

NOSTALGIA for the good earth and getting "back to Nature" drives many a homeowner to lavish attention and care upon his lawn. The intensive grooming that follows, however, sometimes accentuates the damage from the melting-out disease that afflicts turf.

Melting-out is not only the most serious disease of bluegrass in Connecticut lawns: it is intensely interesting to the plant scientist. The disease appears to attack the grass tissue when it is low in sugar. Hence, we call it a low-sugar disease. Any ecological factor, including excessive care, that causes the grass blades to lose sugar causes them to become diseased. Among these environmental conditions are too-close cutting, too much nitrogen, and too much cloudy weather. We shall show how these factors contribute to development of the disease.

Melting-out appears following cool, wet weather in spring. It is first apparent when small light brown spots appear in leaves and stems. Sometimes the spots have purple margins. As the disease progresses, the spots become numerous and the fungus infects the crown. Once the crown is infected, the tillers stop growing, die, and turn brown. In the turf these dead tillers appear as brown patches an inch or more in diameter. In effect, the turf melts out. Once the disease has run its course, recovery is retarded by the low vigor of bluegrass in warm, dry weather. The remnants of the foot-rot phase in summer are commonly mistaken for drought damage.

Studies here and elsewhere have shown clearly that melting-out disease is less intense in bluegrass turf mowed 2 inches or higher than it is when the grass is mowed 1 inch or lower. With the shorter cuts, the turf produces less sugar from photosynthesis but uses more sugar to grow additional tillers and leaves. This results in a net lowering in sugar content of tissue and, hence, an increase in susceptibility to disease.

Intensive care in the form of high nitrogen fertility (6 lbs. of nitrogen per 1,000 square feet during the season) is more conducive to disease than casual care with a lower level of nitrogen (1 or 2 lbs. of nitrogen per 1,000 square feet). We have found that the form of nitrogen is not important in disease development, but when the weather favors the disease, turf responding to high nitrogen levels is severely attacked. Release of nitrogen from organic fertilizers is slow, however, and may occur after the disease-conducive weather passes. High nitrogen fertility may lead to increased disease susceptibility by diverting leaf sugars to amino acids and other nitrogen products.

Low light intensity favors disease, apparently through curtailment of sugar production. We did not appreciate this until last year when we were working on a fungicide test. We had an epidemic of disease going during cloudy, wet weather in May, and tried to prolong the epidemic by extending the wetness with sprinkling. To our astonishment the turf recovered in June regardless of treatment. During June there were only three days of overcast weather, and only two of these were consecutive. Presumably, the June sunshine enabled the turf to raise its sugar content and recuperate from disease. The duration of cloudy weather thus is more critical to disease development than is the amount of rainfall.

A cool temperature and adequate moisture causes bluegrass to grow vigorously, and the rapid growth keeps the sugar content low by consuming the metabolite as it is produced. Cool, wet weather may thus predispose the turf to disease. The effect of cool temperature on *Helminthosporium vagans,* the pathogen, is not clear. A moist environment favors disease, but we do not know whether free water is essential for infection.

Resistance to this low-sugar disease differs with the variety of bluegrass. Merion is most resistant, followed by Newport, Windsor, common Kentucky, and Park, which is the most susceptible. If melting-out were the only problem, the disease could be avoided by growing Merion bluegrass, in which leaf sugar apparently runs high. However, Merion is attacked by high-sugar diseases such as stripe smut, powdery mildew, and rust. These diseases are caused by fungi that thrive on living host tissue, unlike *H. vagans,* which extracts its food from the host tissue it has killed. Bluegrass varieties that are resistant to low-sugar disease are susceptible to the high-sugar diseases, and vice-versa. We plan further exploration of this intriguing relationship. Perhaps we can aid the geneticist in breeding resistance to both types of disease into one variety of grass.

Turf specialists have attempted to combine resistance in turf by planting a mixture of two or more varieties of bluegrass. Problems of compatibility limit the value of this control measure. After several seasons, the variety that is favored by management practices predominates.

Melting-out can be prevented with fungicides. Weekly sprays during the spring give excellent control of disease. A one-shot treatment in early May in the form of a drench is as effective. Both of these control measures are impractical for use by the homeowner. Attempts to apply the one-shot treatment in granular formulation have yet to prove satisfactory because of difficulty in concentrating the required amount of fungicide.

Our strategy in chemical control has returned to the fungicidal spray, but with its application geared to disease-promoting weather. Based on the habits of the fungus and the dynamics of disease development, a double application of fungicide should prevent an epidemic of disease and subsequent increase in inoculum of the pathogen. The first spray is applied during an extended period of overcast weather in the spring and the second 10 days later. Once an epidemic occurs, however, fungicides merely reduce inoculum of the pathogen and do not necessarily hasten turf recovery.

Recovery from melting-out is hastened by whatever promotes tillering in bluegrass. Here is where attentive grooming pays. Thus, adequate moisture and fertility during clear weather following overcast periods speeds recovery. To avoid promoting disease because of high nutrition, however, fertilizers should be applied late in the spring or the nitrogen should be in forms slowly available.

The first step in the control of melting-out disease in Kentucky bluegrass lawns is to check the "spring-fever" urge to lavish excessive care on the home lawn. With a more rational approach, one can minimize the loss of turf from the disease.

New Publications

The publications listed 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.

Entomology

B680 *Differences in development of strains of the gypsy moth, Porthetria dispar (L.).* David E. Leonard.

B681 *Boxwood Pests and Their Control.* John C. Schread.

Report on Inspection

B679 *Commercial Fertilizers, 1965. Part II: List of Registrants, Tonnages Sold, and Analyses.* H. J. Fisher.

Farm and City Profit

(*continued from page 8*)

quickly showed that zein, the corn protein, lacks lysine—an amino acid. When lysine from another source was added, the rats lived happily on the corn. And thus was born the epic discovery that the amino acid building blocks of protein differ in nutritive value. This discovery lies at the very foundation of modern human nutrition. Osborne got his gold medals for this. Kwashiokor, the dreaded weaning disease of African children, is caused by an amino acid deficiency.

Our studies on hybrid corn add immensely to the world's food supply, our studies of amino acids to its quality.

A recent discovery at the Station is zineb, a fungicide that protects the world's potato crop from the dread blight disease, the disease that brought mass starvation to Ireland little more than a century ago.

Most agricultural chemicals have their first successful test on farmers' crops and move later to the city man's flowers. The first successful field test of zineb was made on the city man's roses right here in the Pardee Rose Garden of New Haven. It moved later to the farmers' potatoes.

It was tested on farm crops in its first year, but a severe drought dried up the disease on our test potatoes and celery. New Haven used sprinklers to water the Rose Garden. This substituted for the rain, encouraged the disease, and "discovered" the effectiveness of zineb in the field.

Such are the influences and results of our city environment.

Jenkins' statement in 1904 bracketed the city man's milk and the farmer's profits. Our research encompasses both, because the city man's food supply depends on a healthy American agriculture.

Farm and City Profit From Agricultural Research

James G. Horsfall
Director

NUMEROUS VISITORS to the Experiment Station express astonishment at finding an agricultural research center in the city. "I thought you would be in the country," they say. I must admit that I was astonished, too, when I first came to this Station.

Only recently did this apparent anomaly fall into place in my mind. I discovered a quotation from W. O. Atwater, chemist and first director, who wrote in 1875, ". . . paradoxical as it may seem, the abstract researches which bring the most practical benefit to farming are made, not on a large scale in the country upon the farms, but in the towns where a small number of plants can be experimented with. . . ."

Obviously our founders put us in a city and they put us in a city deliberately. How has their judgment worked out?

Our founders said also that we were "to put science to work for agriculture." How can you do *that* in the city? I don't think that the city inhibited Jenkins from introducing the shade tent into Connecticut tobacco culture, Morgan from thinking up the principle of the soil test on which all modern fertilizer practices are based, or our entomologists from developing new methods for controlling wire worms on potatoes.

The city environment has indeed encouraged us to do things for agriculture that we might not otherwise have done. Take the case of hybrid corn, our proudest discovery. Every corn grower in America uses it. The people who are astonished to see that we are in a city are also astonished to learn that the great principle of hybrid corn was discovered in Connecticut, not in Illinois, Indiana, or Iowa.

I submit the following evidence that the city and hybrid corn are related. At the turn of the century, our Director Jenkins, a city boy in origin, foresaw it with remarkable prescience.

Even though he had no children of his own, he foresaw that our research had to lead to more milk for the children that would be born into urban Connecticut. He wrote in 1904 "There will always be a demand for fresh milk in Connecticut. . . . The corn crop is the cornerstone of a paying dairy industry." Note that Jenkins was concerned both with milk for the city and profit for the farmer.

Fitting deeds to his words, Jenkins set out by train for the Corn Belt in 1905 to interview a young corn breeder named E. M. East. Later Jenkins wrote East, "Our object in inviting you to join us is to have you engage at once in the study and practice of corn breeding in Connecticut, with the end of securing more valuable crops. . . ." Whereupon East came east.

Thus was transferred from Illinois to Connecticut a brilliant scientist who "engaged in the study and practice of corn breeding" so well in Connecticut that he was invited to a chair in botany at Harvard. From there he sent students to New Haven in the summer to work for us on corn breeding. One of these was D. F. Jones. It was he who invented the "double-cross" hybrid corn. It was he who invented a method for making inventions in corn breeding. It was he who showed how to grow enough corn in Connecticut to feed the cows to produce the milk to nourish the children of Connecticut citizens.

Nowadays the milk for all the children of the U.S. comes from cows fed hybrid corn. The children get their milk, the farmers get their profit; and Jones got the gold medals and scrolls of appreciation.

And so we are in the city and so we discover a principle used to improve the well-being of city people by improving the well-being of agriculture.

The policy paid in another way.

Because corn was so important as a food for cattle, Osborne and Mendel at this Station long ago investigated its role in nutrition. They bought some white rats and fed them corn as the sole source of protein. The rats grew poorly. Corn protein was not enough. Experiments

(*continued on page 7*)

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BRUCE B. MINER, *Editor*

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Director

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