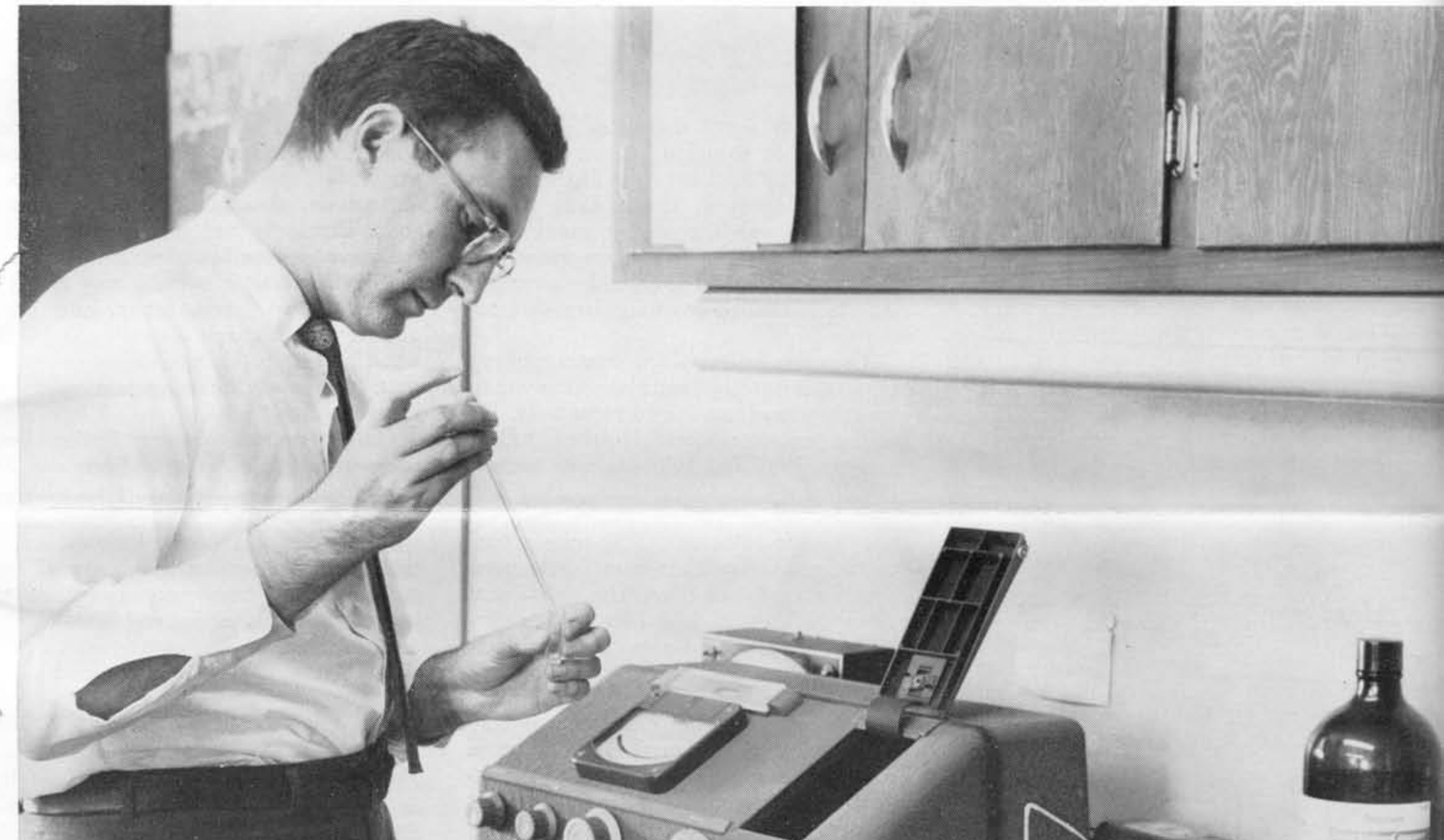
Frontiers of PLANT SCIENCE

FALL ISSUE

1962



Milton Zucker reports on study of phenolic compounds in plants . . . see page 4.

THE CONNECTICUT

AGRICULTURAL EXPERIMENT STATION

NEW HAVEN

The Third Resort

The use of insecticides is to an economic entomologist the last step to be taken only after all other methods of control have been found wanting. The classical approach to insect control has always been, first, to study the life history of the pest, with the hope of finding some way to avoid its damage. If that is unsuccessful, the second approach is to study the parasites, predators, and diseases of the insect. If these offer no relief, the use of insecticides to prevent serious economic losses is considered as a third resort.

Neely Turner
FRONTIERS, May 1954

Uncomfortable Decisions

Man is not a detached director of affairs like the gods of Olympus. We are born and die, eat plants and animals, and in turn are fed upon by plants (disease organisms) and animals (parasites). We compete with other animals whose requirements for food and other resources are the same as ours. We are subject to natural forces and inescapably are a part of nature.

...To meet competition, plants and animals must use whatever means they have at their disposal. It is natural, therefore, for us, too, to use our resourcefulness. Whether we use our means wisely is another matter, but it is natural.

...

Our wisdom in controlling our plant and animal competitors will come, not from ceasing to shift the balance of nature, for this we must do, but from the understanding of directive forces governing populations. We may thereby more intelligently decide our actions.

...

Our way of life is changing, whether we like it or not. Our struggle for existence and our competition, even among ourselves, are becoming more complicated. More and more uncomfortable decisions and choices will have to govern our actions, for nature is not a personal friend of ours, regulating its creatures in numbers to suit us.

Raimon L. Beard
FRONTIERS, May 1959

How Better Forest Management Can Help Control Gypsy Moths

Neely Turner

THE GYPSY MOTH defoliated some 83,000 acres of woodland to some degree in 1962, in addition to the 55,000 acres that were sprayed. The severity of the defoliation was increased in many areas by the infestation of cankerworms and linden loopers, which caused serious injury to 36,000 acres and noticeable feeding on 87,000 acres.

The possibility of preventing gypsy moth damage by methods other than spraying has been raised repeatedly. Effective parasites imported by the U.S.D.A. between 1905 and 1929 are now present in all parts of Connecticut. They kill many gypsy moths, but obviously do not prevent outbreaks. The same is true of the predatory Calasoma beetle, now firmly established here. The polyhedral virus disease that killed so many caterpillars in defoliated areas last spring is latent in the population. It apparently becomes effective only when caterpillars have insufficient food, or weather is very unfavorable for them. These biological agents, and native parasites and predators (including birds and rodents) do not now and may never operate in such a way as to prevent serious outbreaks of the pest in highly susceptible woodlands.

Forest Stand Can Be Changed

Prevention of infestation by forest management was proposed by Clement and Monro in 1917. They advocated removal of trees susceptible to attack, particularly trees of low economic value. In 1936, Behre, Cline, and Baker renamed this practice, calling it silvicultural control. Each went into detail with suggestions for applications of the method, and pointed out that the changes proposed were in the direction of improvement of the woodlands whether or not gypsy moth was a problem.

There is little doubt that the principles advocated in these studies will reduce the hazard of serious infestation by the gypsy moth. The idea is to reduce the percentage of oaks, gray birch, aspen, willow, and linden to less than half (and preferably one-third) of the total stand on such dry sites as hilltops or on sandy soils. Hemlocks and pines may replace the more susceptible trees. Encouraging the development of shrubs may also be helpful. Gray birch, aspen, and even oaks seldom thrive in these dry locations and this sort of change increases rather than decreases the economic value of the woodland.

On the more moist and fertile sites, the percentage of favored hosts can be more than half of the total stand without risking heavy infestation. These areas will also support birch, hickory, tuliptree, ash, and maples which are all desirable forest trees not susceptible to gypsy moth. White pine and hemlock are also suitable.

Idea Tested In Use

These principles of "good" forest management have been applied successfully in a few commercial and state forests. Such managed woodlands have had much less infestation by gypsy moths than other unmanaged areas in the same vicinity.

Since this is a preventive method, it works best when it is started at a low point in gypsy moth infestation. This gives an opportunity for resistant species and undergrowth to grow larger before the gypsy moth becomes troublesome. It also allows time for seedling hemlocks and pines to become established if these have to be planted.

Owners of woodlands interested in avoiding the expense and other disadvantages of spraying might consider management as an acceptable alternative. In stands that are now 75 to 100 per cent "favored hosts," a spray might be needed to protect planted hemlocks and pines. In more diversified stands on moist sites, reduction of favored hosts should be sufficient.

Stephen W. Hitchcock Tells of

Aquatic Insects and DDT

Few people realize the number of insects that are underfoot whenever they go wading on a hot summer day. In a clear Connecticut stream, each square foot of stream bottom may contain up to 200 insects that are easily visible and many others that are too small to be seen readily. Some of these insects are herbivores that graze on algae or detritus, others are carnivores that stalk their prey over rocks and through mossy underwater jungles. A whole world lies here, unseen by human eyes; a strange world that may be just a few feet wide but several miles long.

Apart from their inherent interest to the biologist as subjects for his scrutiny, these insects are of value to the sportsman as forage for trout and other fish, and to the general public as indicators of stream pollution.

Among other contaminants, an occasional gypsy moth spray can decimate the insect population of an individual stream. In order to examine these effects in Connecticut, investigations were made of four streams that were sprayed in the course of gypsy moth spraying and of one stream that was not.

The insect populations within these streams were measured before and after spraying and for 3 years thereafter in spring and fall. Ten, square-foot samples were taken each time from each stream. All insects were removed from within this area, counted, and identified. Although the total number of insects was reduced in every stream by the insecticidal spray, for several reasons it was considered to be of more importance to check the *kinds* of insects that survived. The biotic potential of most insects is large and if a few manage to survive, they can repopulate the stream within a relatively short period of time. But if a species is completely removed, then repopulation of the denuded stream must await migrants from other streams. In this regard, the insects are probably more important than the trout, because the state has an active stocking program for the trout but no equivalent program for the insects upon which the trout feed.

Recovery of the insect fauna depends in large measure upon the size of the area sprayed. Fortunately Connecticut sprays only limited areas for the gypsy moth at any one time. Loss of fish at the dosages used for gypsy moth control has been reported several times in this country and Canada. Some of this loss was caused by starvation because the death of the aquatic insects removed the fishes' main food source.

DDT Persists On Vegetation

If the headwaters of a stream are left unsprayed, "insect drift" from upstream will help to repopulate the sprayed portion. DDT is carried away by the water in about 24 hours so that after one day, new insects can presumably recolonize. Unfortunately, however, DDT can persist on the aquatic vegetation for at least 2 months, according to studies made elsewhere.

In Connecticut, the loss of species is quite heavy in any one stream, but nearby streams will not suffer the loss, necessarily, of the same species. One week after spraying, treated streams had lost from six to thirty per cent of the genera that had occurred before the spray was applied, as compared with an untreated stream. However only two insects were eliminated from all the treated streams. The caddis flies were hit the hardest, whereas the dragonflies, dobsonflies, and some of the mayflies were more resistant. In some groups, such as the stoneflies, the carnivorous forms were more apt to be killed than the herbivorous forms. Three years later the streams had essentially recovered. If there had been unsprayed portions of the brooks upstream, recovery would have taken place more quickly.

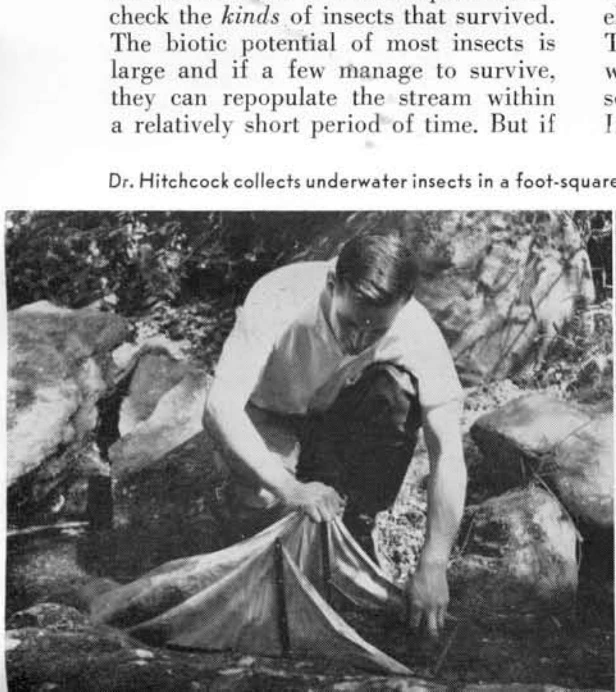
Concurrent with the stream studies, laboratory tests showed the exact amounts of DDT that were fatal to various species and determined if the insects that survived a spray were truly resistant or had habits that protected them from the spray.

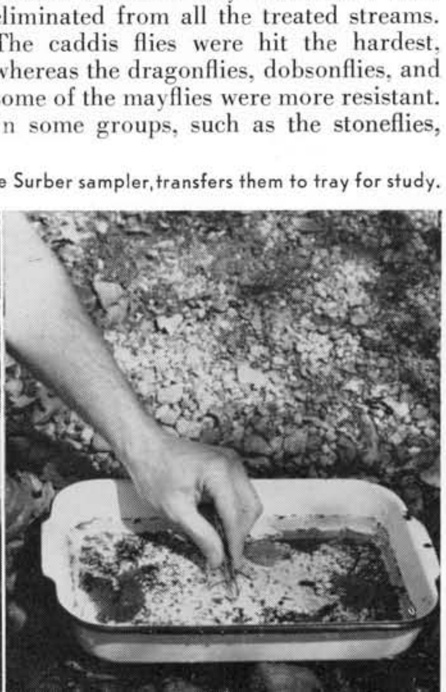
We thus learned what is the normal course of events in a sprayed stream in Connecticut. This served not only to pinpoint the dangers of insecticidal sprays but also could be used as a yardstick for reports of kills of aquatic life from routine spraying.

An example of this occurred in the spring of 1962 in Granby. A naturalist in that area reported numerous dead frogs and a dead trout in a small stream shortly after spray had been applied for the gypsy moth. When these frogs were analyzed in the laboratory, it appeared that they had indeed been killed by DDT. An examination of the stream showed that the only insects left in the stream were those that laboratory tests had shown to be most resistant to the toxic effects of DDT. Luckily, however, those susceptible insects that were pupae at the time of the spray managed to survive also to provide a nucleus for future generations. Because of previous laboratory tests on the amounts of DDT that various insects could endure, it was possible to estimate the approximate amount of DDT that had reached the stream a few weeks earlier.

Needless destruction of wildlife is disturbing to almost everyone. Until ways are found to control an insect pest without damage to other living things, occasional unfortunate deaths will occur in natural populations of animals. It is hoped that field studies and laboratory tests will indicate ways to reduce these incidental and accidental deaths to a bare minimum.

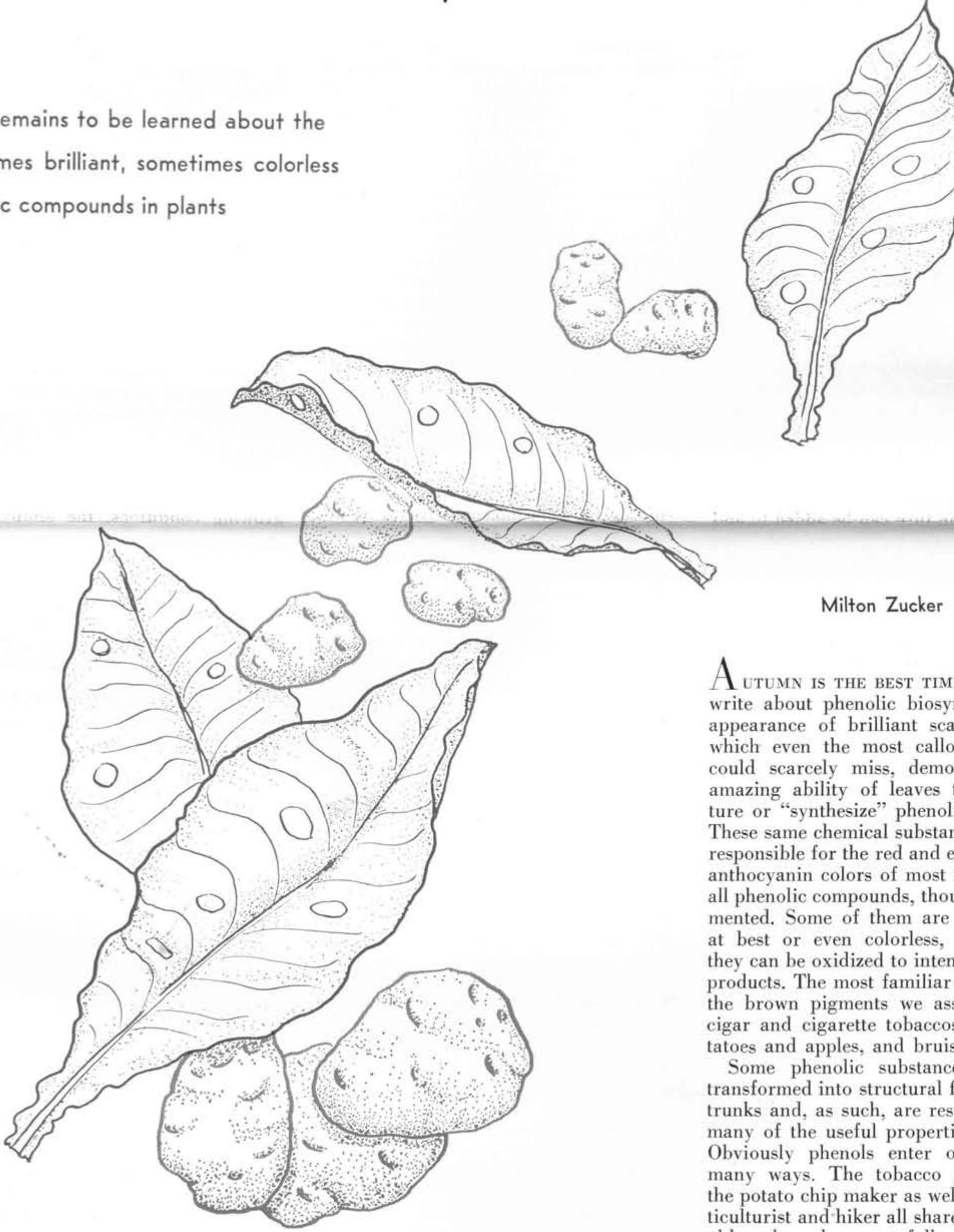
Dr. Hitchcock collects underwater insects in a foot-square Surber sampler, transfers them to tray for study.





Phenols, Potatoes, and A Possibility of Redder Roses, Sturdier Trees

Much remains to be learned about the sometimes brilliant, sometimes colorless phenolic compounds in plants



Milton Zucker

Autumn is the best time of year to write about phenolic biosynthesis. The appearance of brilliant scarlet foliage, which even the most callous observer could scarcely miss, demonstrates the amazing ability of leaves to manufacture or "synthesize" phenolic pigments. These same chemical substances are also responsible for the red and even the blue anthocyanin colors of most flowers. Not all phenolic compounds, though, are pigmented. Some of them are pale yellow at best or even colorless, but usually they can be oxidized to intensely colored products. The most familiar of these are the brown pigments we associate with cigar and cigarette tobaccos, sliced potatoes and apples, and bruised fruits.

Some phenolic substances are also transformed into structural fibers in tree trunks and, as such, are responsible for many of the useful properties of wood. Obviously phenols enter our lives in many ways. The tobacco grower and the potato chip maker as well as the horticulturist and hiker all share a common, although perhaps not fully appreciated, interest in phenolic biosynthesis. The fact that phenolic substances are manufactured by almost all plants and often in very large quantities makes them scientifically interesting, too.

Several years ago I began a study of the phenolic components responsible for the brown color of cured tobacco leaves. This study has since grown into a full-scale investigation of phenolic biosynthesis. Several other scientists at the Experiment Station have become intrigued with plant phenols and much of the story told below reflects their work as well.*

Fortunately the major phenolic substance converted to brown pigments in curing tobacco leaves had been isolated, and its complex chemical structure had been determined. This normally colorless phenolic compound, called chlorogenic acid, is also found in a wide variety of other plants. Coffee drinkers like me consume about a half pound of the substance a year just from this source.

Leaves Are Storehouses

Knowing its structure, we set out to find how the tobacco leaf makes chlorogenic acid. That was no easy task, for leaves are vast storehouses of chemicals and contain literally thousands of them. Furthermore, most of them are manufactured right in the leaf from simpler chemical structures, and once put together, they in turn can be added to and otherwise transformed chemically into further products. We had to discover the pathway, the assembly line by which the leaf converts relatively simple raw materials into complex chlorogenic acid molecules. That is, we wanted to find the starting materials for this manufacturing process and then follow them step by step as they were converted from one intermediate substance to another until the complete biosynthesis of chlorogenic acid had been achieved. If this could be done, we would be in a good position to regulate the phenolic composition of the leaf.

The most direct approach was to feed the leaf with chemicals of known composition which might be used as raw materials. This was done simply by floating disks cut from leaves on solutions of our chemical "hopefuls" such as common table sugar. This substance is transformed, or metabolized, by any one of a number of pathways in most tissues and is often a raw material for biosynthesis. When green tobacco leaf disks were fed on a sugar solution, they increased slightly in chlorogenic acid content. However, the amount synthesized during the experiment was so small in comparison to the amount already present in the tissue that the increase was difficult to measure.

Potatoes Suitable For Study

Reports from other laboratories suggested the potato tuber as a more appropriate tissue for this study. Potatoes, like tobacco leaves, appear to be capable of synthesizing chlorogenic acid, but normally contain very little. We again repeated our sugar feeding experiments, this time using thin disks of potato tissue cut from the inner part of the tuber. We were happy to find that after several days, disks fed on sugar had synthesized readily measured amounts of chlorogenic acid. Here then was a nice experimental setup in which to study the pathway of chlorogenic acid synthesis. Not only did the tissue respond well, but it could be obtained in 100 lb. bags or, in an emergency, from my wife's kitchen.

Although the sugar effect was a good test of the system, it unfortunately didn't tell us much about the biochemical pathway to chlorogenic acid. What we needed was an intermediate product much closer in structure (actual shape) to the final chlorogenic acid molecule. Again an article in one of the more than 200 scientific journals available at the Experiment Station gave us a clue to the next step. Canadian workers had shown that phenylalanine, an amino acid found in all living organisms, was a good precursor (it could fit right into the middle of the assembly line) of phenolic pigments in buckwheat plants. The similarity in chemical structure of the phenylalanine molecule to a part of the chlorogenic acid molecule suggested that it might also enter our potato system. Indeed, when slices of potato were allowed to feed on a phenylalanine solution overnight, they increased 10-fold in chlorogenic acid content, a very dramatic effect. Further experiments with radioactive phenylalanine proved that it was directly on the pathway to chlorogenic acid.

A logical first step in the transformation of phenylalanine was its conversion to a substance called cinnamic acid. Although this material can not normally be obtained from plants, it is synthesized chemically, and bottles full were available for feeding. As predicted, this chemical also stimulated chlorogenic acid synthesis. However, none of the other compounds on our chemical shelf were appetizing to the potato slices. Nor could we find any other likely intermediate substances in the potato tissue itself. Apparently, each missing building block was converted to the next intermediate as soon as it was formed and had no chance to accumulate until the final chlorogenic acid stage was attained.

Our only hope was to clog up the whole chain of events which converts phenylalanine into chlorogenic acid and allow these rapidly transformed, short-lived intermediate substances to pile up. We found we could do this by feeding the potato slices large quantities of phenylalanine, shoving in more raw material than could be handled smoothly on the biosynthetic assembly line. When we analyzed potato slices after their 2-day orgies on phenylalanine, we were able to isolate what we think are the missing intermediate substances. One of them turned out to be a completely new chemical compound not previously found in plants.

With these findings we can now describe at least that part of the biosynthetic assembly line which transforms phenylalanine into chlorogenic acid. We still don't know how the tissue carries out these transformations or where phenylalanine comes from, but at least we have an outline of events to work with now.

Recently Dr. Hanson perfected an elegant method of separating complex mixtures of plant phenolics. With it we were able to make much more detailed analyses of the phenolic composition of potato tubers. We found that under normal growing conditions, the ability of the tuber to make phenolic substances is severely limited by a lack of intermediate building blocks such as phenylalanine. Results of scientists elsewhere also suggest that other plants could use a lot more of such compounds than they normally get for phenolic synthesis.

Intriguing Possibilities

Thus, our studies so far suggest that supplying these substances is a good way of altering the phenolic composition of plants. I do not mean to say that we'll be able to make a redder rose or a sturdier tree tomorrow, but some exciting and unexpected avenues are opening up. For instance, plant pathologists talk about the possibility that phenols are natural substances which make plants resistant to disease. Perhaps our recently acquired knowledge of phenolic biosynthesis will lead to a new application of plant chemotherapy. Some phenolic substances have also been implicated as plant hormones. A knowledge of their biosynthesis could also be useful in our attempts to encourage and direct the growth and development of plants.

In scientific research it is often good to follow your nose. Just as finding the key word in a difficult crossword puzzle leads to a whole series of new combinations, the emergence of a new concept or idea from research can open up many unsuspected possibilities.

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* Dr. Carl Levy, formerly of our Biochemistry Department, carried out extensive research on phenolic biosynthesis. At present, Dr. Kenneth R. Hanson of that Department is conducting a very fruitful attack on the problem. Dr. John Ahrens at Windsor has also been interested in tobacco phenolics, and the competent technical assistance of Mrs. G. H. Trepanier has done much to increase the breadth and interest of this story.

BEETLES AND BORERS ADAPT AND SURVIVE:

CAN WE DO MORE THAN OBSERVE?

Raimon L. Beard

INSECTS SHOW remarkable adaptations to their environment. Among the hundreds of thousands of species are some which thrive in cold arctic regions or snow-covered mountain tops; many thrive in the tropics or even in hot springs. Some live in water, others in wood, many in the soil. Scarcely anything is free from the feeding or soiling by insects—even rubber and lead cable may be chewed.

Some insects are "miniaturized" to an amazingly small size, complete with all tissues and organs; others are a foot long. Insect shapes and color patterns are countless. Some insects develop in a few days; one requires 17 years to mature.

Some have such a simplified way of life they are little more than animated vegetables; others have a complex biology and live in social communities. Such wide ranges of adaptations are the result of evolutionary changes which have gone on for millions of years.

In recent years we have become more conscious of evolutionary changes that take place almost before our eyes. And some of these changes explain why we have difficulty in keeping insects under control. The development of resistance to insecticides is one such adaptation. This has become widespread and has been shown to result from selective processes favoring those insects whose genetic make-up gives them a better chance to survive in the presence of the insecticide.

Corn Borer Changes

Sometimes adaptation makes an insect less troublesome than formerly. In Ohio, for example, the European corn borer used to have one generation each year and attacked corn at its most vulnerable stages, causing great crop losses. Entomologists have observed that over a period of time the insect adjusted to two generations per year and, curiously enough, does less damage. The first generation comes too early to damage corn so severely. Later in the season the corn is much better able to withstand the attacks of the second generation. In Connecticut, too, where we have always had the two-generation strain, there has been some kind of an adjustment, for the borer is not so destructive as it once was. We are not sure what this adjustment is, nor all the reasons for the borer declining.

Japanese Beetle Adapts

The Japanese beetle is now showing signs of modified behavior that will bear watching. Twenty years ago adult beetles would congregate by hundreds and thousands on fruit trees, grapes, rose bushes, and many other favorite food plants. Grass turf in fine condition would be completely destroyed in a short season by the grub stage of the beetle. Sometimes 250 grubs could be found in a single square foot of turf that could not possibly survive such attack. We see nothing like these infestations now. Dozens of beetles may assemble on a rose, but not hundreds. Turf is still damaged, but by 10 to 20, not 100 to 200, grubs to a square foot.

This decline was brought about by several influences. For several years the weather was exceptionally dry at a time when beetles were laying eggs. Many eggs failed to hatch or the larvae failed to develop. Large areas of turf favorable for beetle breeding were treated with insecticides, which effectively "grub-proofed" lawns, public parks, golf courses, and cemeteries. Parasites were released. They colonized, persisted, and have effectively reduced the numbers of beetles locally. Spores of the "milky disease" were spread in suitable areas throughout Connecticut. There are now locations where disease spores are so numerous that a beetle grub has a poor chance of avoiding infection. Even so, damage to turf may result, as the disease kills slowly. But no beetles emerge.

One might expect this decline in beetle population to continue to the vanishing point. But insects can adapt.

There are indications both in Connecticut and elsewhere that the Japanese beetle is increasing in some localities. This could be a temporary result of some weather situation favorable to the beetle. Observations also permit another explanation which, if true, would suggest that the beetle could increase, perhaps appreciably, for some years.

When most abundant, the Japanese beetle bred almost exclusively in the best turf. Only occasionally was it to be found in rough grassland, pastures, or cultivated soil. Accordingly, it was on the good lawns given special care where insecticides were applied, disease was established, and parasites were encouraged. Whereas the grubs from eggs deposited in such areas have found it harder to survive, those in the rough grass have had an easier time. Now, more and more grubs are to be found in rough turf or cultivated ground in proportion to those in good turf. It may be that this greater ease in survival is selecting those beetles genetically constituted to deposit eggs in turf that we used to think was unattractive to the beetle.

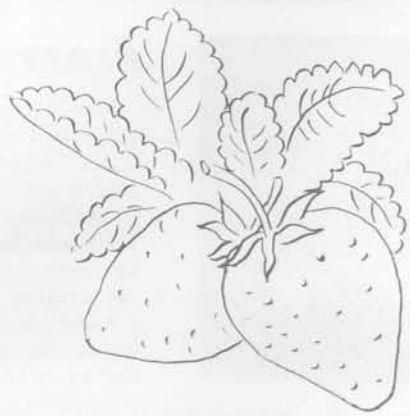
May Become More Numerous

We may be seeing, then, an adaptation in beetle behavior that will stop the decline in beetle populations and may even permit a rise in numbers depending upon how completely the beetle comes to prefer the different environment.

As the adult beetle can fly considerable distances from dispersed breeding areas to favorite food plants, the presence of many beetles does not necessarily mean the failure of grub control nearby. We thus have an explanation of why the beetle may be locally abundant where it "should not be."

Being aware of some adaptions that develop within a relatively short time makes us wonder how many important ones occur unnoticed. Biologists have long been aware of great variation among individuals of a species and know that variation is a prerequisite to adaptive behavior and genetic selection in insects. Learning about adaptation is one thing. To control it in our favor is a bigger problem.

Pathologists Test A New Way To Fight Fungi With Fungi



Bruce B. Miner

GOOD SCIENTISTS, amateur or professional, are curious. They wonder about the stars, or the sea, or—in this story—about strawberry plants and the diseases they are heir to.

The scientists are Saul Rich and Patrick M. Miller, plant pathologists at this Station. They seek practical and inexpensive ways to lessen the likelihood that root-destroying fungi will kill strawberry plants in the field. Heat and chemicals used as soil treatments have long protected plants from fungi in greenhouses and plant beds. But both methods are expensive and seldom used in the field except for crops of unusually high value.

Biological controls of root-destroying fungi are always operating in the soil. If these controls can be made more effective, if a simple method can be devised to encourage "good" fungi to attack "bad" fungi, the plant pathologists' curiosity may pay off in techniques profitable to the grower and gardener. And without use of chemicals.

In an experiment that suggests some of the complexities that go with every attempt to understand life processes, Rich and Miller put to work two fungi known to be antagonistic to plant-damaging fungi. These good fungi have no common names: they are known only as *Trichoderma viride* and *Penicillium urticae*. The scientists wanted to learn the effects of these beneficial fungi on the destructive fungi that cause Rhizoctonia root rot and Verticillium wilt on strawberry roots.

Much Goes On In The Soil

If the good fungi are to attack the bad in the soil, the two must get together, intimately, in a battle area that is always crowded. Much goes on in the soil, and a few million bits of fungi or their spores, spread over an acre, can be killed or starved before they even meet the bad fungi.

So Rich and Miller tried to give the attacking fungi what sound logistics demands—effective transport, quartering, and supply.

The Trichoderma and the Penicillium fungi first were grown in the laboratory for several days on moist, sterilized wheat seeds. The antibiotic the fungi secreted into the wheat, the scientists reasoned, could protect the wheat from other microbes in the soil. Then the wheat seeds were air dried and mixed into the top few inches of soil in field test plots. Transport, quartering, and supply were provided.

Compared with seeding rates for wheat, Rich and Miller used a lot of seed. You can grow an acre of wheat with from 60 to 100 pounds of seed. They applied 700 pounds to the acre of one fungus-loaded lot of seed and 300 pounds of the other in separate areas.

The wheat seed was dead, of course, killed by high temperature treatment before inoculation with the fungi. So there was no stand of wheat seedlings, but a massive inoculation by fungi.

Plants Inoculated

Strawberry plants were set after the wheat seeds had been in the soil for a week. Some plants were inoculated with Verticillium, some with Rhizoctonia, and there were the usual untreated check plants.

In due time Rich and Miller found that one antifungal fungus, the Trichoderma, had won over Rhizoctonia. Scientists do not say that fungi fight, or lose, or win. They say that the results were significantly different from those on the untreated check area.

The Trichoderma fungus came from Connecticut soil. The Penicillium did not. The native strain scored a victory over Rhizoctonia; the foreign strain failed to do so. The foreign strain may have encountered troubles it had not previously known.

Neither one of the good fungi conquered Verticillium, here called a bad fungus. On the contrary, based on the number of plants showing Verticillium wilt, both lost.

Where there are campaigns, there are camp followers. One of the antifungal fungi, the Penicillium, actually increased the severity of Verticillium wilt.

Here, the camp follower was not a fungus but a microscopic worm, or nematode, with a Latin name perhaps a thousand times longer than the creature itself. When the Penicillium fungus was added to the soil, something happened that favored this nematode and its kind. They feed on the cortex or outer layer of roots and so expose root tissues to fungal attack. Verticillium, in this instance, effectively mounted the attack against the strawberry roots.

There was much more to the experiment by Rich and Miller. They tested chemical materials for control of Rhizoctonia and Verticillium also.

But the biological control part of the experiment is typical of the challenge to scientists of apparently simple things. It is the story of the contest between one fungus and another. And it is also the story of the seemingly unequal contest between plant pathologists on the one hand and brainless simple plants on the other. In this second contest, the plant pathologists have knowledge and techniques; the simple plants have a few million more years of experience.

The fungi and the nematodes, the strawberries and the stars, are parts of our environment. They volunteer no information. But they do give clear answers when we are keen enough to pose the right questions.

New Publications

Publications listed below have been issued by the Station since you last received FRONTIERS. Address requests for copies to Publications, Box 1106, New Haven 4.

Ecology and Forestry

B 652 Proceedings of the Lockwood Conference on the Suburban Forest and Ecology, edited by Paul E. Waggoner and J. D. Ovington.

Entomology

B 650 Common Connecticut Flies, Robert C. Wallis.

Other Subjects

C 222 Poison Ivy Eradication, J. F. Ahrens and E. M. Stoddard.

Reports on Inspections

B 651 Commercial Feeding Stuffs, 1961, H. J. Fisher.

James G. Horsfall

From the Director

Paul E. Waggoner is head of our Department of Soils and Climatology. Last spring Dr. Waggoner invited 10 distinguished biologists to meet in New Haven for the first Lockwood Conference, a meeting made possible by income from the Lockwood Trust, an endowment of the Station. The subject of the conference was the Suburban Forest and Ecology. In the first of eight papers presented during the conference, Dr. Waggoner discussed the need for research on the suburban forest, "the greenery we see day in and day out." I found his observations thought-provoking, and therefore have invited him to present in this column a digest of his paper. The full report of the Lockwood Conference on the Suburban Forest and Ecology, Bulletin 652, is now available (see New Publications, page 7).

TWO SURPRISING PHENOMENA of our times are the miraculous increase in productivity that feeds more and more people from each acre, and the technology that taps ancient reserves of carbon for fuel and fabric.

We are, I believe, both the eyewitnesses and the heirs of the most dramatic release of resources the world has thus far known.

Six centuries ago a less beneficent releaser of land, indeed a satanic liberator, cut a swath across Europe. Men called it the Black Death and it swept away perhaps a third of the people in its path.

The release of land, and of people from the land, in our time has not come with the terror of pestilence. But it has left fields untilled and farmsteads unwanted. Our clothes of productivity, so generously fashioned, hang loose upon us despite our growing numbers. We are too small for our breeches.

We are uneasy, like a farm boy newly transplanted in the city, as we seek to adjust our old and familiar ways to new realities. At the same time we know that millions of people elsewhere in the world would like nothing better than to match our opulent attire.

Farmers are abandoning land faster than it is demanded by cities. Coons and skunks multiply, having discovered their affluence in the garbage pails of the anxious exurbanite now living on forsaken land in the suburb.

It is these haunts of the coon and the skunk, these lands of the car pool and the PTA, that with their greenery comprise the suburban forest that concerns us.

Open Space And Ecology

"Open space" is the 1-acre that busies the suburbanite's weekends, the matrix of the turnpike exchange, the handsome grounds of the new power plant. It is the abandoned pasture invaded by red cedars or the second-growth oak invaded by gypsy moths.

This is the suburban forest we want to understand, perhaps improve. We needn't spend our time speculating whether it will be, whether it should be, or whether it need be promoted. It already is, it is increasing, and it will last for many years.

We need spend our time learning how to live comfortably with it. This remark introduces ecology, because ecology is the study of how plants and animals live together, how they are ruled by their environment, and how they modify the environment.

In all manner of husbandry, ecology is interesting. But in suburban forestry we hope to grow perennial plants with ease and live among them comfortably. Hence, ecology becomes critical as well as interesting.

Our natural business is natural science. We follow the fruitful methods of natural science: circumscribe a system, forgetting all else; propose laws that predict the behavior of the system; test them; and use those that work. We use these methods for the same reason that the laws are used: because they work. Because they work, an unending and ever accelerating cycle is begun.

The responsibility of scientists grows with their success. And want this responsibility or not, we have it. When man can do nothing, he need know nothing. When he has means to work changes, however, his knowledge of consequences must be better. A scientist is not wiser in his choices, and his vote counts no more than any other in setting a course, but as technology enables a course to be followed, scientists increasingly need to know consequences of courses—with certainty proportional to the power of the technology that makes the change effective. Unfortunately, coming to know is slower than deciding upon a course, and we must anticipate the many natural problems that will arise from a great variety of courses, state them as questions, and seek answers.

I suggest that among these questions may be:

What plant stand creates a micro-climate that is airy in the summer and snug in the winter? How can the forest composition be promptly bent to our will?

What are the consequences of the changes we can shape? How can we create variety, an insurance against oversight?

Finally, what stands of plants yield the most water? The suburban forest is the cup in which we catch our water as well as the medium in which we live.

Paul E. Waggoner

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