Frontiers

of PLANT SCIENCE

FALL ISSUE NOVEMBER 1959

Genetic studies yield better tobacco . . . see page 4

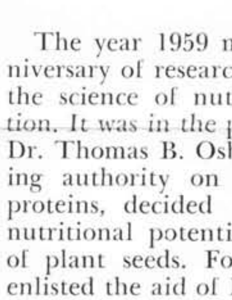
THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION • NEW HAVEN

George Smith and Lester Hankin mix one of many test diets used in research on nutrition.

Research in Nutrition at the Station

Lester Hankin

The year 1959 marks the 50th anniversary of research investigations in the science of nutrition at this Station. It was in the period 1908-09 that Dr. Thomas B. Osborne, then a leading authority on the chemistry of proteins, decided to investigate the nutritional potential of the proteins of plant seeds. For this venture he enlisted the aid of Professor Lafayette B. Mendel of Yale University, who was already well known in the field of nutrition. Thus began a lengthy collaboration which was extremely fruitful. Their initial experiments (the first one was dated July 5, 1909) were comparisons of the rate of growth of albino rats fed different proteins. Osborne had previously found certain of these proteins to be widely unlike in amino acid composition. These early experiments led to the discovery of Vitamin A and to the recognition that certain amino acids are essential in the diet. When Osborne died in 1929, Mendel continued this work until his own death in 1935.



Lester Hankin, who is responsible for vitamin and related determinations, is a graduate of the University of Connecticut with the Ph.D. degree from North Carolina State. Dr. Hankin also carries on research in biochemistry.

A second cycle of nutritional research at this Station began in 1935 under the direction of Dr. Rebecca B. Hubbell. New investigations were made on the adequacy of experimental diets, long term studies of growth were undertaken, and the use of the albino rat for the bioassay of Vitamin D was studied. Portions of this work were carried out in collaboration with investigators at Yale.

The Station is now well into a third cycle of nutritional endeavor which began in 1954. The present investigations in many ways parallel and in some ways continue the patterns of research in nutrition established by Osborne and Mendel 50 years ago. It may be that the old adage "history repeats itself" can be amended to read "scientific history repeats itself."

The study of growth factors has always been of great interest. Many times new factors are discovered by chance. Such was the case with Osborne and Mendel, who noted that some of the proteins they were feeding to rats, although supposedly adequate, were alone not able to sustain good growth. On further investigation they found that something present in certain fats was needed to supplement the diet. The fat-soluble Vitamin A was thus brought to light. The parallel in nutritional research today is illustrated by a study on filicidal cannibalism among female rats. We found that this behavior could be remedied by the addition of dried liver powder to the diet. Although we suspected that Vitamin B_{12} is involved, we cannot yet exclude the possibility that unknown growth factors in liver are involved.

The investigations during the first quarter of this century on the growth of rats also have a present-day parallel. Today we know what constitutes a good diet and what happens when a poor diet is fed. However, there are many non-nutrient and non-toxic substances which can affect growth. An investigation recently completed illustrates this. A report had appeared in a scientific publication to the effect that a dilute solution of hydrogen peroxide, when given in place of tap water, was effective in curing rats in which a certain disease had been experimentally induced. However, tests were made only on diseased rats. We tested the effect of hydrogen peroxide on the growth of normal rats. These rats failed to gain weight as expected, primarily because they limited their intake of the peroxide solution. This information affected the interpretation of results previously reported in the scientific literature.

A third aspect of the present work recalls the early studies on vitamins by Osborne and Mendel. Nucleic acids and related compounds are becoming increasingly important today in nutrition. Accordingly one of the precursors of nucleic acid is being fed to rats and the resulting biochemical and nutritional effects studied in collaboration with colleagues at Yale.

What has been the outcome of 50 years of nutritional endeavor at this Station? Research here has made important contributions to the science of nutrition. In the first phase the investigation of vitamins was begun, and the value of certain proteins and amino acids in nutrition was established. In the second phase the value of other nutrients was examined. And, what of the third and present phase? Is there really a parallel between "then" and now? Perhaps only another 50 years will tell.

Edit Advanced Treatise

Editors of *Plant Pathology, an Advanced Treatise,* are Dr. James G. Horsfall and Dr. A. E. Dimond of this Station. Dr. Paul E. Waggoner and Dr. Saul Rich of the Station staff are among the contributors to this three-volume work published by Academic Press. Volume 1 became available in October.

RUSSIA REVISITED

Christopher Bingham

Christopher Bingham, graduate of Yale, is in his second year of graduate study at the University and has a fellowship at this Station where he is doing research in the field of climatology.

On June 15th, 1959, I left New York embarked on a most interesting and exciting trip. I was headed for the Soviet Union with the Yale Russian Chorus on its second informal singing tour of that country. The chorus, composed primarily of Yale students interested in and informed about the Soviet Union, was hoping to be able to further understanding of America on the level of the Soviet man in the street. Once in the USSR we kept up an exhausting but exciting schedule of day-time tourism and night-time singing. In addition, I did my best to meet with Soviet scientists in agricultural climatology to discuss with them my own work as well as to get a picture of the state of this science in the USSR. I had visited Russia with the Chorus in 1958.

This year we visited Moscow, Leningrad, Riga, Lvov, Yalta, Kiev, and Sochi. A typical evening consisted of an informal concert in a park or on a street corner. Inevitably a large crowd would gather, and after roughly three-quarters of an hour we would break up, those who could staying to talk. Thus I had many opportunities to meet with and talk with Russians—students, workers, soldiers, old folk. Quite often I had the opportunity later to talk alone with a few of those I met this way. I was always extremely impressed by the warmth and friendliness of the people. Very seldom did I see active resentment towards us. Generosity is almost a religion. Hardly an evening passed without my receiving some spontaneous gift from the crowd—a pen, a book, a souvenir pin. Also I couldn't help but be moved at the willingness to sacrifice their own positions by being seen with me alone, for it is still dangerous to have much contact with foreigners.

Perhaps the most striking characteristic of the Soviet people is their intense curiosity about the West, especially about America. This was not limited to the obvious points such as prices, policies, and problems, but included abstract art, modern music, and American dating habits. Most people realize the limitation imposed on the scope of their knowledge and want to fill out the gaps. Frequently people can be brought to make concessions away from the official line when a cogent argument can be presented.

"Peace" is a commonly heard word there. The Soviet people suffered much in the last war and sincerely and passionately want peace, and this feeling is being exploited to the utmost by the government. Russians are taught that the Western governments, not the people, are the cause and supporters of world tensions, an idea which accords well with the line that there is a great gulf between our government and our people. Peace seems to be the topic which most concerns the average man when he thinks beyond his day-to-day life.

Propaganda has a way of backfiring. Several times I had people ask "Is it really true that our Sputniks are better than yours?" The government has declared so many times the superiority of Russian accomplishments when it has obviously been untrue, that even when such a superiority exists it is doubted.

The atmosphere the tourist breathes in the USSR is deceptively free, especially on a first trip. He is permitted liberties which he does not expect and is not generally aware of any surveillance or control. However, this year I was acutely conscious that this was far from true. Not only was I on several occasions very obviously followed, but later I learned that several people whom I had met and known well had had trouble after my departure—in one case removal from the university, in another, loss of a job. This is a side I do not like to recall, but it is one that should not be passed over in silence, no matter how much we may want to believe in the reality and the completeness of the "thaw."

I have returned to the United States with a much clearer understanding of Soviet reality and the situation of the Russian people. The warmth and friendship experienced can in no way obscure the coldness of dictatorship.

The Moskva River at the Kremlin. Photo by Mr. Bingham.

Fleck-resistant inbred (left) compared with a susceptible variety, Conn. 49, at the Tobacco Laboratory in Windsor, August 1959. Note especially the contrast in condition of the lower leaves.

What the Tobacco Plant Does to Ozone

Seaward A. Sand

●Weather flecking in Connecticut Valley shade tobacco, so costly to growers this year, involves interaction of some kind between genes of the tobacco plant and its environment. Following particular environmental conditions, among them a concentration of ozone greater than 10 to 20 parts per hundred million in the atmosphere for more than an hour or two, the leaf tissue injury called fleck may appear in susceptible varieties.

If we say that in a susceptible variety, ozone "causes" fleck, is it logical to say that in a resistant variety, genes "prevent" fleck? In an environment of continuous, moderate ozone concentration, the resistant variety would not fleck, whereas the susceptible variety would fleck. Under these conditions we may consider either that the "susceptible" genes cause fleck or that the disorder called fleck is an hereditary ailment.

No evidence points to an infectious organism as a cause of fleck.

Other workers have regarded ozone (an active form of oxygen) as the probable cause of fleck. It is certain that fleck-like symptoms may be induced in selected leaves by exposure to ultraviolet-irradiated air.

If one tentatively assumes that ozone is involved, the question may be asked: What does ozone do to the tobacco plant to result in fleck injury? But some leaves show no fleck symptoms despite ozone treatment. This strongly suggests that these leaves act to protect themselves against ozone injury. From this viewpoint, an appropriate question is: What does the tobacco plant do to ozone?

Close-up view of typical 12th to 15th leaves in late August 1959 for the varieties shown in photo at the top of this page. The fleck-resistant inbred is on the left, Conn. 49 on the right.

My point is that genes are a critical part of the internal environment of the plant, and they are subject to change in dosage (as is ozone concentration) by appropriate but time-consuming methods. Considering genes in this way gives a new perspective to the problem of weather fleck.

The whole question of fleck clearly has many dimensions. Search for a single cause is easier, but study of interacting systems may be more fruitful in understanding the disorder.

To predict whether a single tobacco leaf will or will not develop fleck symptoms we need to know and understand the effects of at least five variables: The variety or strain of tobacco (genes present), the stage of development of the plant and the particular leaf, the cultural environment as it affects the physiology of the leaf involved, microclimatological factors immediately preceding, during, and after exposure to ozone, and finally, the ozone concentration and duration of that concentration.

Above-threshold doses of ozone in tobacco fields may come from the upper atmosphere, from the action of ultraviolet light on oxygen, or from reactions involving hydrocarbon contaminants in the air. Fleck may be controllable some day through reduction of atmospheric contamination by industrial wastes and automobile exhaust fumes, or through meteorological control. We cannot now control fleck by these methods.

To understand how fleck may be controlled, our knowledge of plant physiology helps to lay the groundwork. The damage presumed to be due to ozone apparently can occur only if the leaf stomates are open and so permit entry of ozone into the local air spaces of the leaf tissue. Thus the physiology of the guard cells affecting the stomates may be involved, and environmental conditions other than ozone concentration may affect fleck resistance.

Decreased light intensity through shading and decreased turgor under conditions of limited soil water and high transpiration may result in closed stomates and so reduce fleck injury. Physical blocking of the stomates with dust, chemical treatments to close these doorways, or antioxidant sprays to reduce local concentrations of ozone appear to be effective in reducing fleck injury. Time of application is all-important: the treatment must be made before threshold concentrations of atmospheric ozone occur.

It is unlikely that all resistance to ozone is confined to the mechanisms affecting the stomates. Some bio-

Dr. Seaward A. Sand, (Cornell, 1954) was a teacher of science at Horseheads, N. Y. He joined the Station staff in 1954 to conduct tobacco breeding studies with special reference to disease resistance.

chemical protective or repair system is probably operating, as evidenced by the greater resistance of young leaves and of some varieties. On such a biochemical system we now speculate, we do not know.

We can measure the relative intensity of fleck-producing conditions in the field by comparing the performance of particular tobacco inbreds in different years. Our records on this basis show that of the past five seasons, 1955 and 1958 were nearly identical in fleck stimulus. With those years as a standard of reference, conditions this year were greater than 17 per cent more severe, in 1956, more than 19 per cent less severe, and in 1957, more than 40 per cent less severe.

In the same 5-year period we have scored 4,720 field-grown plants for symptoms of fleck. Forty-six families were represented: 22 shade tobacco strains and 24 different hybrid generations. Weighted averages, adjusted for year-to-year differences in fleck stimulus, show that fleck-free individual plants among the 22 inbreds varied from none to 91 per cent. We assume that a genetic basis underlies these average differences.

For seven different hybridizations between fleck-resistant and susceptible parents the following relative differences among pooled average frequencies of fleck-free individuals were obtained, having the indicated 99 per cent confidence intervals:

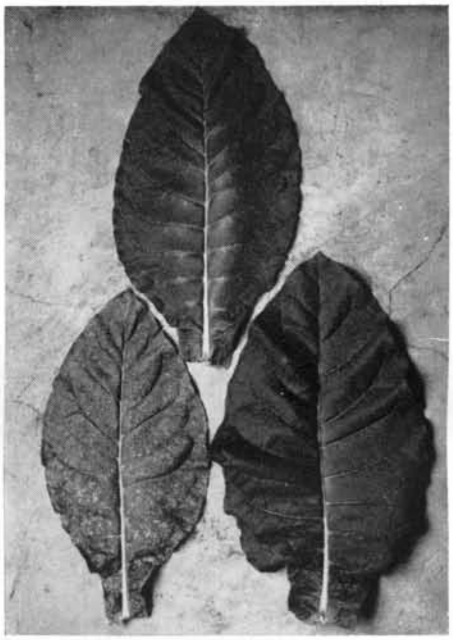
Susceptible Parents, 0% of 1150 plants, 0 to 1%.
Resistant Parents, 92% of 631 plants, 88 to 95%.
F_1 Hybrid Generations, 64% of 516 plants, 57 to 71%.
F_2 Hybrid Generations, 43% of 384 plants, 35 to 52%.

These results indicate an average F_2 performance which is equal to the average of the two parental types. However, the average F_1 performance, while intermediate, is significantly better than the average of the two parents, and suggests partial dominance of genes or dominance of some genes for fleck resistance. Results in F_3 and F_4 generations show success in selection for fleck-resistance genes.

Accurate evaluation of experimental material has been especially easy under the severe flecking conditions of 1959. Highly significant correlations among measurable components of resistance have been found for 16 families grown during the 1959 season.

Resistance Can Be Built In

It is now clear that appreciable natural resistance to fleck-inducing conditions can be built into the tobacco plant genetically. Leaves of the fleck-resistant strains of tobacco keep their resistance longer than do the leaves of varieties commonly grown. In this respect the leaves seem to hold a resistance to fleck found in young leaves of even the most fleck-susceptible varieties. Early in the season or under less severe conditions, the resistance is a practical immunity. In terms of time, the best of these resistant strains appear to add 3 weeks of grace against fleck by extending a juvenile characteristic through the critical period of tobacco harvest. Under the severe conditions of 1959, one resistant strain averaged only four flecked leaves and another eight flecked leaves to the plant. On the same date, when leaves 7 to 9 would



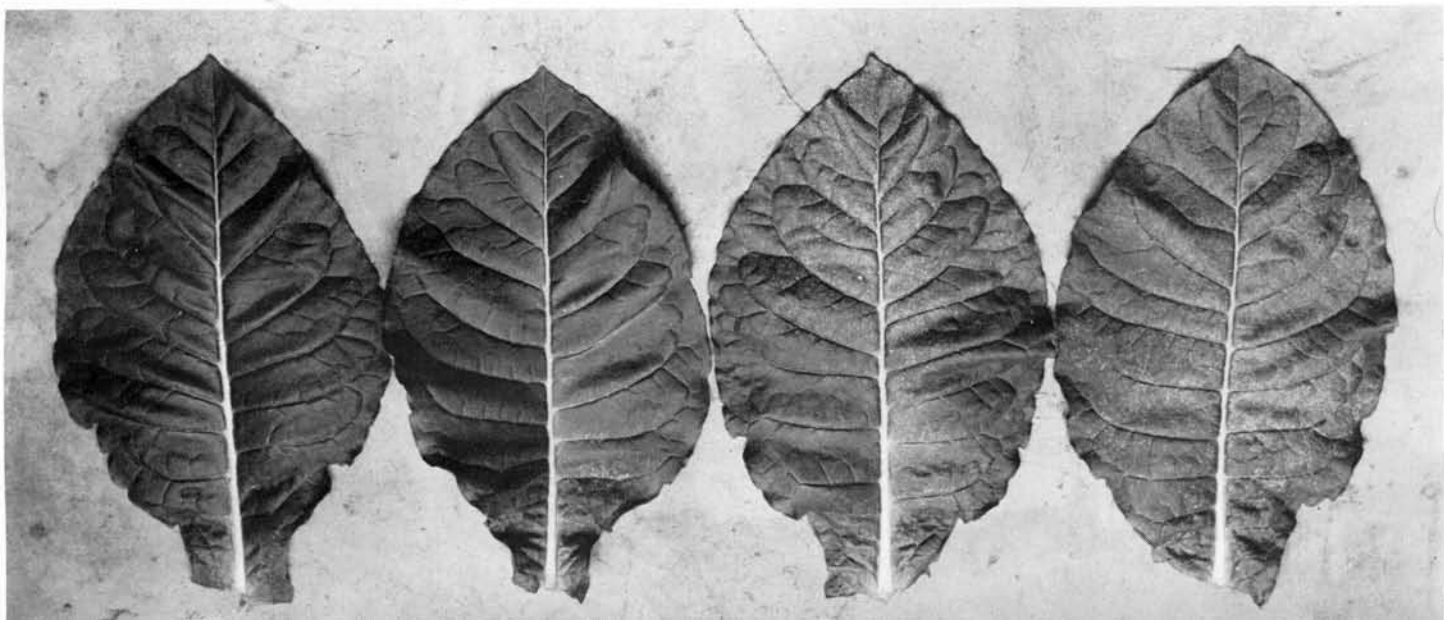
Typical 6th leaves on July 22, 1959 from Conn. 49 (lower left), fleck-resistant parent (lower right), and F_1 hybrid (upper center).

have been picked, susceptible varieties had an average of 13 flecked leaves.

A hybrid plant with half its genes from one parent and half from the other is intermediate between the parents in fleck resistance. When the number of genes from a resistant parent is experimentally varied, the family of resulting plants shows individual differences in fleck susceptibility. This variability may be five times as great as that for an inbred family. The difference is statistically significant and is a measure of the power of genetic control over fleck symptoms under severe conditions. However, the number of genes involved cannot be large because, following a hybridization, the resistance genes of the parent have been reassembled within three generations of selection. It is this genetic informa-

(*Continued on page 8*)

Typical 6th leaves on July 22, 1959 from four plants of an F_2 generation following the cross between fleck-resistant and fleck-susceptible varieties. Symptoms range here from none (left), as for the resistant parent, to severe fleck symptoms (right), as for the susceptible parent.



Chemotherapy Breaks Par

E. M. Stoddard and Raymond J. Lukens

A Rutgers graduate, Raymond J. Lukens is on the staff in Plant Pathology, working on lawn diseases and on fungicidal action. He received his doctorate in 1958, University of Maryland.

A tournament was coming up in three weeks and the greens at the Golf Club were in considerably less than satisfactory condition. They had "brown patch," "melting out," and chemical injury from too many applications of various fungicides at excessive concentrations. The fungicides had been put on in a losing last ditch battle against the "brown patch" and "melting out." At this point the problem of getting these greens in condition for the tournament was given to us along with a fervent prayer of hope that we could solve the problem at once.

We relate the story of what was done and the attendant results, not as a technique based on experimental data but as an application to this specific problem of various facts already known about nabam, a fungicide capable of controlling the causal fungus of "brown patch" and accelerating the formation of roots on plants when injected into the soil where the plants are growing. It was also known that another fungicide, thiram, used as a spray, would control "melting out."

We reasoned that if nabam were injected into the affected greens, it would control the "brown patch" and accelerate the formation of new roots on the grass, thus enabling the grass to come back quickly to a condition of normal growth. Given normal growth, we believed that less frequent and more thorough sprayings of thiram would control the "melting out."

Accordingly, we suggested a program of treatment, which was put into operation on the stricken greens. Nabam at a concentration of 1 to 600 in water was injected at 150 pounds pressure into the greens to a depth of one foot at four-foot intervals. (Incidentally, this operation excited much curiosity and caused some chagrin among the golfers playing through the greens.) Subsequent to the soil injection, appropriate sprayings of thiram were made as planned. As we tell you of the results please do not ask what happened to the untreated greens. There were none; this was an emergency program, not an experiment, and untreated greens had no place in it.

Now, what about the results of this program. It worked, and at tournament time three weeks later the greens were in acceptable condition for play! Both diseases had been adequately controlled and thanks to the ability of nabam to accelerate root growth, the grass was putting out many new roots. With the resultant increased growth the grass was filling in the thin spots satisfactorily. The players apparently were not concerned about the few bare spots that still remained but were enthusiastic about the fact that the balls "stuck" to the greens and their scores were in the low 60's. This characteristic, we found, was due to the loosening of the compacted soil by the injection of liquid under pressure, making a softer surface and reducing the bounce of the ball. This effect was not foreseen in the original planning.

At the time of this writing, two months after treatment, the greens are almost completely covered with a vigorous turf, with roots penetrating to a depth of six inches in the loosened soil and with practically no evidence of disease. It would seem that indeed golf scores have been improved by chemotherapy!

A 20-Year Record on Treated Poles

A. R. Olson

Wood posts and poles can be treated with a preservative rather quickly, but evaluation of the treatment under field conditions takes years. We have now kept track of 45 poles of maple and black and gray birch treated in 1938 and set in a tobacco field of the L. B. Haas Co. in Hazardville in 1939. Treated with zinc chloride by the tire-tube (modified Boucherie) method, these posts have been in continuous service ever since, except for two years between removal in 1942 and resetting in 1944.

These poles were inspected at 5-year intervals beginning in 1944. Without treatment, useful life of these poles would not have exceeded 5 years. In 1949, after 8 years in the ground, all treated poles were sound throughout. After 13 years in service, 4 per cent had failed at ground line or below and 11 per cent had failed in the tops. This top failure was unexpected: poles usually fail at or just below the ground level. Later investigations showed that the failure in the tops was accounted for by low concentration of zinc chloride at the end farthest from the point of application. With the tire-tube method, the solution is applied to the butts. A simple correction for this unequal distribution is to stand the poles upright with the treated end up for about two months after treatment.

A. R. Olson began work at the Station in 1927 on graduation from the N. Y. State Ranger School. The work reported here was begun by Henry W. Hicock, retired.

After 8 years in service, the poles also showed a softening of the outer layers of wood below the ground line. Wood thus affected crumbles between the fingers. After 18 years many poles had become eroded to a depth of one-half to one inch and were failing because of reduction in cross section. This eroded wood does not look like that attacked by fungi. We suspect that this erosion is due to action of the zinc chloride or its reaction products.

Despite these failures, the service record of these poles is remarkably good, considering the low costs of materials and labor. After 13 years, 84 per cent were in serviceable condition: after 18 years, 44 per cent.

Another lot of 15 spruce and pine poles, treated in the same way, were tested at Windsor. Service expectancy of these poles, untreated, was no more than 3 to 4 years. Some decay developed in the tops of these treated poles, as at Hazardville. Even so, after 10 years in the ground, 93 per cent were in good condition. In 1959, after 20 years, 80 per cent were serviceable. Softening of the outer layers of wood on these poles was only superficial, one-eighth of an inch or less.

50 Years in Retrospect

E. M. Stoddard

A half-century is a long time to look forward to but in retrospect it shortens amazingly. It is hard to realize that it has been some forty years since Henry Kiley drove the horse and buggy to the New Haven post office at 3:30 each afternoon to get the Station mail.

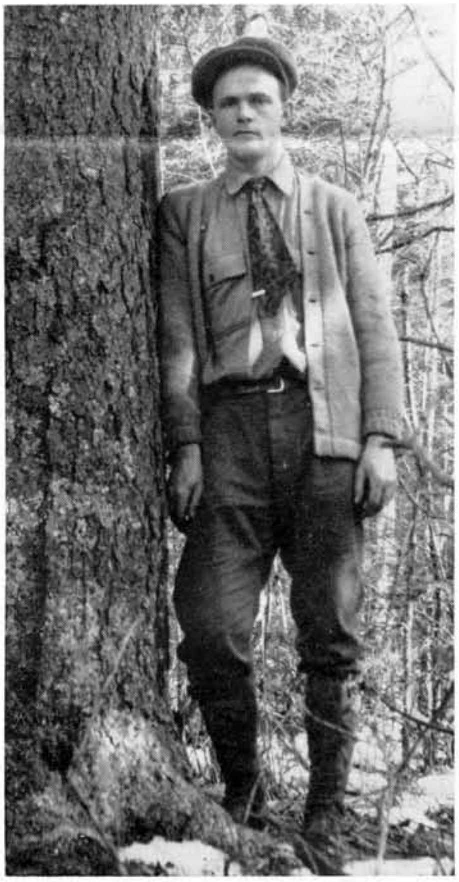
Or again, that it was 49 years ago that a small group of farmers gathered at the old Farm (which is now Norwood at the intersection of Whitney and Washington Avenues in Hamden) for the first Field Day. Need we say that on that first Field Day there was no tent, no public address system, no tractor tours, no committees, and no automobiles. The staff and guests came on the trolley or drove a horse. And it is still harder to realize that there were only 18 persons on the Station staff in 1909 when the first Assistant Botanist of the Connecticut Agricultural Experiment Station started his career in the now Thaxter Laboratory by tipping over a beaker of water into the lap of G. P. Clinton, the head of the Department of Botany. Many beakers have since been upset but none so well remembered.

Entomology, also a two-man department, was upstairs in the same building. Soon a stenographer was shared by the two departments and we no longer wrote our letters in longhand and made the copies on the hectograph. When we moved into Johnson Laboratory it was from poverty to riches, we had electric lights.

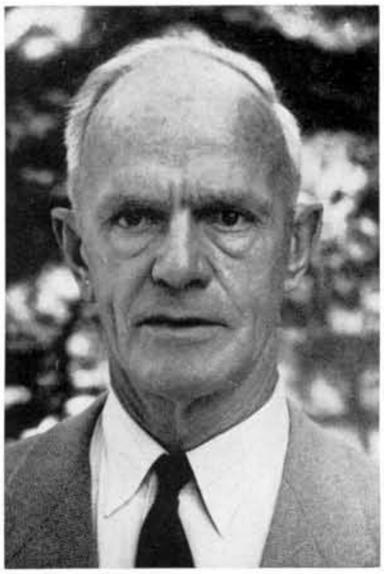
The mention of Johnson Laboratory reminds us of the fire in January 1910 which gutted the building which is now the east end of Johnson. Fortunately, it was an Arctic cold night and the water that normally would have ruined the books in the libraries froze so quickly that not a book was injured beyond a water-soaked cover and a lightly toasted back.

All these things were events and parts of the everyday life of the Station, but what of our scientific activities of yesteryears? Perhaps this can best be told in one short sentence. Then as now "research was our business and discovery our product." We need not mention in detail the work of those years, the record is in the literature of agricultural science. The quantity and subject matter have changed but one cannot say that the years have made much change in the quality of the product.

Of course we did things then somewhat differently from now. We did not jump into a car and roar off down the Turnpike at sixty miles an hour, more or less. We put our supplies and work clothes in a sack and travelled by train, trolley, and on foot to the orchard or potato field. The plots were not randomized, but if we sprayed acres enough and counted many thousands of apples, it could be demonstrated that on the sprayed trees the fruit was better than on the checks. The spraying was done with a hand pump, using sulfur and copper as fungicides and lead arsenate for an insecticide, and we have yet to see where all the complex chemicals and high-power sprayers



Shown here as he took to the field in 1915 or thereabouts, Mr. Stoddard has seen many changes in the Connecticut countryside, including removal of his home, plantings and all, to avoid having the Connecticut Turnpike through the Stoddards' living room in Guilford.



Ernest M. Stoddard continues to give "botanical assistance" to growers, gardeners, and his colleagues. Next month Mr. Stoddard rounds out 50 years on the Station staff.

produce any fancier fruit, although the modern data are much fancier.

If there was an evening speaking date we travelled by the same transportation facilities and stayed overnight, frequently at the home of the chairman of the arrangements committee. I well remember my first experience in this field of endeavor. It was in the home town and there was some disappointment that the gem of scientific lore was not printed in full in the local paper. A later private reading of this same gem provided a logical reason for it not being good copy.

To those of you who are now on your way to *your* half-century of service let me say that it is a wonderful experience and a lot of fun. As I have already said, the backward look is the shortest but the view ahead is the most interesting. We cannot shed tears for "them good old days." They are gone—today and tomorrow are the good days.

New Publications

The publications listed below are now available to those who apply for single copies to Publications, The Connecticut Agricultural Experiment Station, Box 1106, New Haven 4, Connecticut.

Lawns and Turf

C 208 Diseases and Other Disorders of Turf

Report on Inspection

B 625 Commercial Feeding Stuffs, 1958

Other Subjects

B 624 Chemical Control of Weeds and Brush Along Roadsides

Ozone and Fleck

(*Continued from page 5*)

tion which makes a plant-breeding cure for fleck seem feasible.

Certain conflicting suggestions in our data concerning dominance versus intermediacy of F_1 hybrids may be explainable in terms of a threshold value for fleck-inducing stimulus in relation to the resistance system of the plants. Also, although no reliable estimate is available for the number of segregating factors or genes contributing to resistance versus susceptibility in our material, our data do indicate that the number is probably at least four. One other observation is of extreme interest and potential value if confirmed. For the number of flecked leaves per plant scored on the same date from randomized plots the range of variation for one hybridization was as follows:

Resistant Parent, 7 to 11, average 8.8.
Susceptible Parent, 12 to 18, average 15.4.
F_2 Hybrid Generation, 5 to 20, average 12.8.

Transgressive segregation in the F_2, suggested by its range of variability which exceeds that of both parents, may indicate that some resistance genes are possessed even by this very susceptible parent. This opens the possibility of increasing the level of available genetic resistance above that presently at hand in any single inbred. Such a possibility is even more promising following crosses between different resistant inbreds.

Quality determinations on cured leaves have been made each year in conjunction with these genetic studies and through the cooperation of cigar manufacturers. From the standpoint of both quality and fleck resistance certain of our advanced generation selections and certain F_1 hybrids are considered extremely promising. Seed of the material developed at this Station will be made available to growers for trial in 1960.

FRONTIERS
of Plant Science

Vol. XII November 1959 No. 1

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Bruce B. Miner, Editor

From the Director

From time to time in this column, I have discussed some of the epigrams of my distinguished predecessor, W. L. Slate. In them he pithily describes the workings of the Station. One of them already discussed is, "Overorganization breeds mediocrity, and mediocrity breeds overorganization."

Another is, "Along with our basic science, we must put bricks in the wall of agriculture." To many scientists outside the Station, Slate's dictum may seem to contain a contradiction. They define basic research as that which has no practical aim. *Ergo,* research that, perhaps, shapes a brick for the wall of agriculture cannot be basic.

Dr. W. O. Baker of the Bell Telephone Laboratory calls this the paradox of choice. Baker says, however, that man has lived with paradoxes during all of history and he cites Second Corinthians as proof, "As poor, yet making many rich; as having nothing, and yet possessing all things." It is clear that "Bell Tel" men do live happily with the paradox. They do brilliant basic research in solid state physics but they develop transistors, too.

To me this alleged paradox derives from our definitions of basic and developmental research. I hold that basic research is aimed at understanding nature. It aims to advance our knowledge of the world around us. This is substantial scholarship. This definition is positive. It contains no negatives. To exclude anything useful from it, limits basic research unduly. There are as many fascinating things to learn about the biology of blue grass as about the pitcher plant in the bog.

Thus by rearranging their definition slightly—from no practical aim, to understanding nature—we remove the paradox and describe a climate where scholarly basic research and agricultural brick laying live happily together. This at least has been the aim of the Station during its 85 years.

The bricks we make for the agricultural wall are formed and fired in the kiln where our basic research men work. Just this week one of them has discovered something new about wilting in plants. He was looking, however, for knowledge in an entirely different nook of nature. Maybe, now he can make a brick that will be useful in combating drought damage. Who knows? Deserts occupy vast areas of the globe.

You are right, Bill Slate. We must and we do put bricks in the wall of agriculture along with our basic science.

James G. Horsfall

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