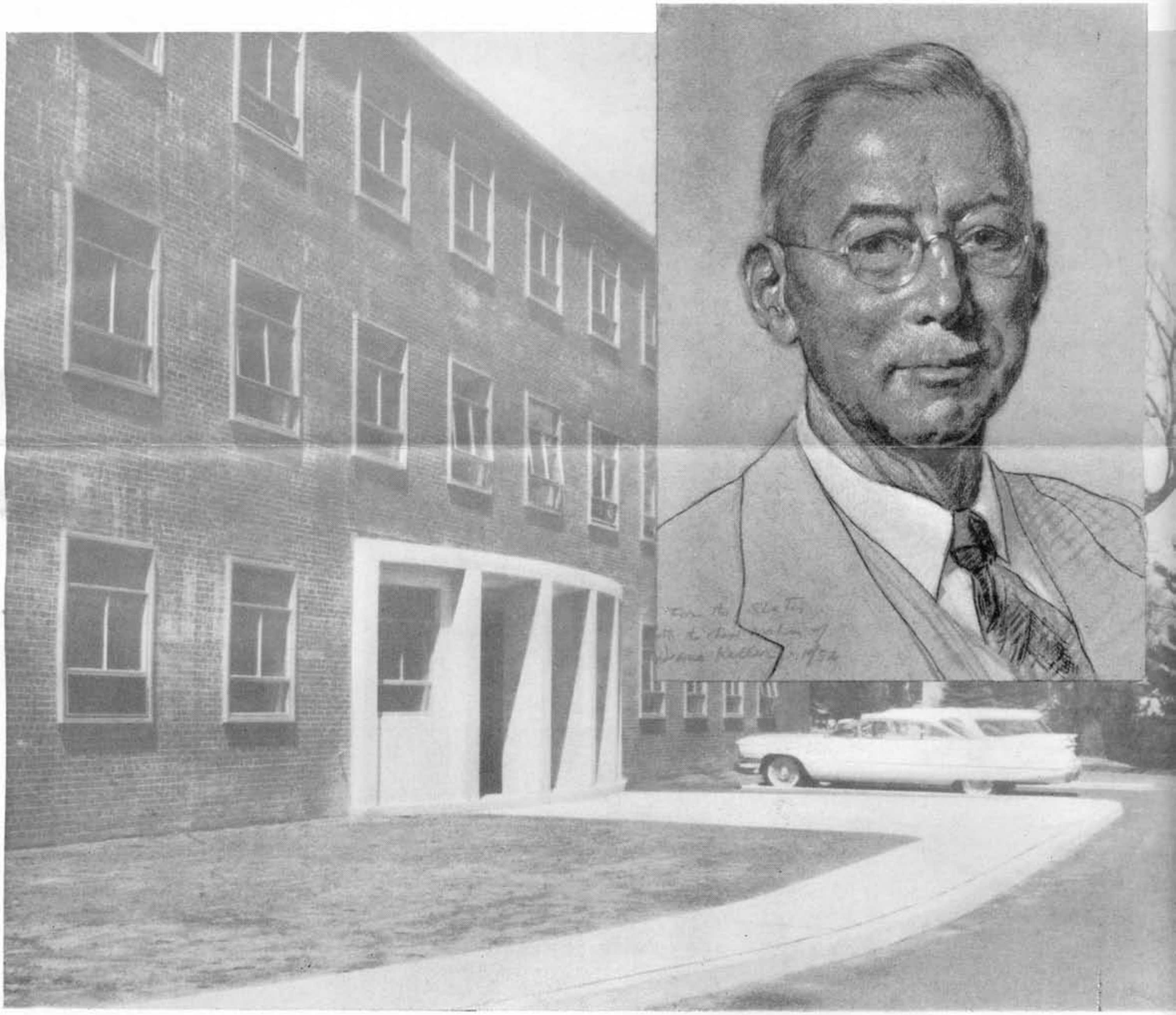
Frontiers of PLANT SCIENCE

SPRING ISSUE MAY 1959



Portrait of Mr. Slate by Deane Keller

Slate Laboratory . . . see page 2

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION • NEW HAVEN

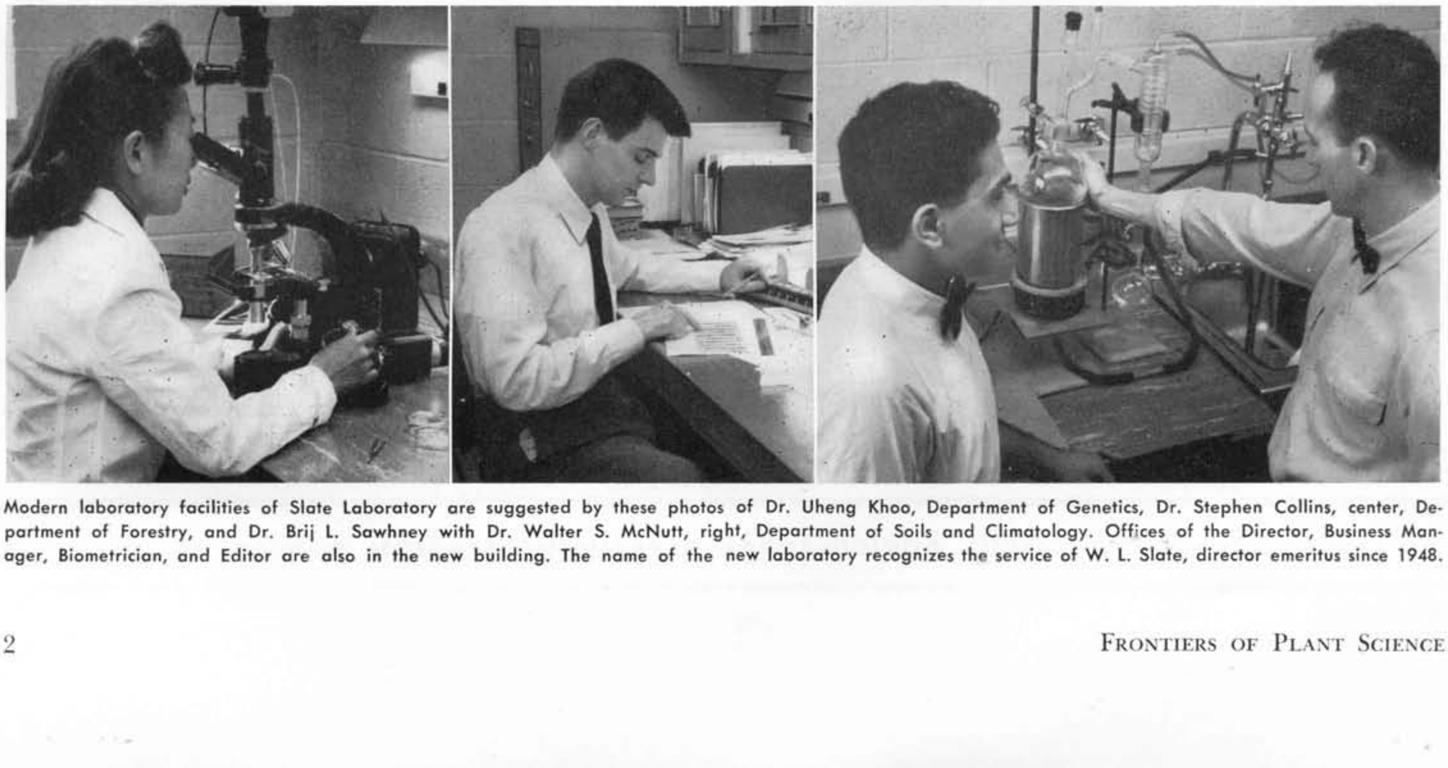
SLATE LABORATORY

The dedication of Slate Laboratory is to be held during an Open House at the Station, 123 Huntington Street, New Haven, on June 9. Edmund W. Sinnott, Sterling Professor Emeritus of Botany, Yale University, and Dr. Paul C. Mangelsdorf of Harvard University will be the principal speakers. Joseph N. Gill, Commissioner of Agriculture and a member of the Station Board of Control, speaking for Governor Abraham Ribicoff, will formally present the laboratory to The Connecticut Agricultural Experiment Station as a research unit of the Station in the service of the people of Connecticut. James G. Horsfall, Director of the Station, will preside at the dedication program, which begins at 4 p.m.

No Field Day will be held this year at Lockwood Farm in Mt. Carmel. The Open House in New Haven will give visitors an opportunity to see facilities and investigations that cannot be shown adequately at the Farm. All departments of the Station have planned exhibits and demonstrations. Hours for the Open House will be from 1 p.m. to 8 p.m. The customary Field Day tent will be in place for those who wish to bring a picnic supper or purchase tickets for a chicken barbecue at 6 p.m.

Soil testing service is now conveniently located at the entrance to Slate Laboratory. Station technicians tested 8,950 soil samples in 1958, about half in New Haven and half at the Tobacco Laboratory, Windsor.

Mailing of Frontiers and all other Station publications is one of the responsibilities of R. Richard Nichols, shown in the new mailing room of Slate Laboratory.



Modern laboratory facilities of Slate Laboratory are suggested by these photos of Dr. Uheng Khoo, Department of Genetics, Dr. Stephen Collins, center, Department of Forestry, and Dr. Brij L. Sawhney with Dr. Walter S. McNutt, right, Department of Soils and Climatology. Offices of the Director, Business Manager, Biometrician, and Editor are also in the new building. The name of the new laboratory recognizes the service of W. L. Slate, director emeritus since 1948.

What We Can Learn From a Weed

Harry T. Stinson, Jr.

Harry T. Stinson, Jr., a graduate of the College of William and Mary, began his work at the Station in 1952. Shown above with the "weedy organism" Oenothera, Dr. Stinson is primarily concerned with cytoplasmic inheritance, cytoplasmic male sterility in corn, and other aspects of corn breeding.

A weed may be concisely defined as any plant growing where it is not wanted. But for most of us weed also connotes the idea of a completely useless plant that is frequently a nuisance, and at times eradicated at considerable expense in time, effort, and money.

If this concept of weeds is extended to animals as well as plants, then it can be said that the science of genetics—the study of inheritance—owes much of its development to studies on "weedy organisms." We recall that a widely used animal which has figured in some of the most significant genetic research is the fruit fly, sometimes an annoying insect in our kitchens, and in certain fruit canning industries a real pest. We recall also that the three American geneticists who last year shared the Nobel Prize in Physiology and Medicine were so honored for their genetic research on a pink bread mold of little economic importance, and on a bacterial species all of us regularly harbor in our intestinal tracts without apparent harm. Other examples could be cited, but the fruit fly, bread mold, and innocuous bacterium illustrate the point that the geneticist frequently turns to relatively obscure and even economically undesirable organisms to probe the secrets of his science. These often strange and unknown creatures become the tools of the genetic trade. By the use of these tools the geneticist helps to build the foundations of genetics which serve the breeder in his efforts to improve plants and animals useful to man.

We deal here with a particular weed, the common evening primrose, known botanically as Oenothera. First we might, as the politicians admonish us, examine the record. What have the evening primroses, long studied by geneticists, already told us? From studies which began in Holland in 1886 came one of the first suggestions that the units of heredity—the genes—are not fixed and immutable, but from time to time undergo changes that can affect the way an organism looks and reacts. This process of gene change, called mutation, we now know to be one of the fundamental properties of genes.

Further investigations carried out by distinguished geneticists in Germany, Great Britain, and America revealed that the evening primroses are, paradoxically, true breeding hybrids. Hybrids in most plants do not breed true to type, and if a farmer saves seed from a hybrid he will not get in the following year the same kinds of plants he had in the original hybrid. Many evening primroses, however, produce identical plants generation after generation, even though they are hybrids between distinct species.

Led to Research on Corn

One of the first American geneticists to tackle the evening primrose puzzle was G. H. Shull, whose epochal discovery of hybrid vigor in crosses between inbred lines of corn was the starting point for the development of modern double-cross hybrid corn. It is interesting to note that according to Shull's own account, his crossing experiments with corn were motivated by his studies on the breeding behavior of evening primroses.

But enough of the past performances of the roadside weed. What use can geneticists make of evening primroses today? For one thing, the phenomenon of permanent hybridity interests us. The Oenothera mechanism that makes this possible is one way in which nature maintains hybrid vigor. It is only one way, and not necessarily the most easily duplicated, but it does merit investigation. To this end, one of my colleagues, Dr. Carl Clayberg, is examining the possibility of building an Oenothera-like mechanism into the tomato.

Second, the very genetic aberrations which make evening primroses so different also make them suitable tools for the study of certain fundamental problems of genetics. One of these problems is concerned with a type of inheritance that involves heritable factors outside the genes in the cell nucleus. The hereditary material outside the genes is the cytoplasm, which has been aptly described as the "partner to the genes." In my investigations with evening primroses I have concentrated on the inheritance of chlorophyll, the green pigment of plants. Whatever its function in toothpaste and soap, chlorophyll in plants is essential for the synthesis of food. Important for my purpose is the fact that chlorophyll is manufactured in microscopically visible bodies in the cytoplasm of the cell. The bodies that contain chlorophyll, called chloroplasts, are transferred from parent to offspring just as genes are, but the chloroplasts remain always in the cytoplasm. The chloroplasts, then, are used as cytoplasmic markers which can be easily followed in inheritance through changes in their green color.

It is clear in Oenothera that the fate of the chloroplasts is determined in part by hereditary properties in the cytoplasm—probably in the chloroplasts themselves—and in part by nuclear genes. We arrive at this view on the basis of some genetic juggling experiments which give various combinations of genes and chloroplasts—a juggling act relatively easy to perform in evening primroses. The hereditary role of chloroplasts is best demonstrated in variegated hybrids, that is, plants which are part green and part yellow, or white. In such variegated hybrids the green and non-green parts of the plant have identical sets of genes, derived half from the mother and half from the father, but the chloroplasts in the green parts are derived exclusively from one parent, and chloroplasts in the non-green parts solely from the other parent. The two kinds of parental chloroplasts thus react differently in association with the same genes. Under these conditions the development of the chloroplasts, and consequently the formation of green pigment, is controlled by hereditary factors other than the genes. The extra genic factors must be in the cytoplasm and are very likely in the chloroplasts themselves.

But this is not the whole story, and these results do not mean that genes in the nucleus have no part to play in controlling the development of chloroplasts. To show the role of genes we turn again to a part green, part white, variegated plant. Crosses between a white branch, which is kept alive by food made in the green parts of the plant, and appropriate tester plants replace the set of genes in the white branch with a different set of genes, without, however, replacing the white chloroplasts. If the right tester plant is used, chloroplasts that were white with the one set of genes become normal green with the new set of genes—a clear demonstration that a given kind of chloroplast can be altered by genes.

From these exercises in scrambling genetic components of the cell the concept emerges that the hereditary mechanism responsible for the development of chloroplasts involves an interaction, on some unknown chemical level, between genes in the nucleus and genetic elements of the chloroplasts in the cytoplasm. This genetic system is not unique. Evidence from an increasing number of organisms indicates that many hereditary characters are produced by an interaction of genic and cytoplasmic components.

MAY HAVE PRACTICAL IMPLICATIONS

One consequence of the interaction of genes and chloroplasts in evening primroses is frequently seen in hybrids between species. For example, the cross between a species found in Guatemala and one native to Virginia produces hybrids so yellow that they die within a few weeks after germination. Here the severe disharmony between genes and chloroplasts is lethal. But the barrier to successful hybridization can be circumvented. By a series of crosses the chloroplasts in both the Virginia and Guatemalan species can be replaced with chloroplasts from a third, Canadian, species. We now have as parents plants which have the same genes as the original species, but which possess different chloroplasts. When the two species with Canadian chloroplasts are crossed, the resulting hybrids are fully green and vigorous. The chloroplasts from the Canadian species evidently are able to develop and function properly with the genes of the hybrid. Through the manipulation of cytoplasmic components—chloroplasts in this instance—we have obtained viable hybrid gene combinations which could not otherwise be produced. Other crosses similar to the one described tell us that the various evening primrose species have chloroplasts with different hereditary properties, and hence different capacities to form the vitally necessary chlorophyll pigment.

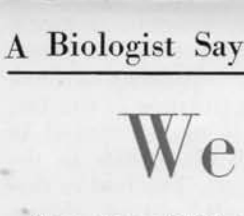
These studies on the inheritance of chlorophyll may have practical implications. At present, the ultimate source of the food we eat is the green plant, which can make complex organic compounds from the raw materials in the soil and atmosphere. An absolute essential for this manufacturing process is chlorophyll. The demonstration that chlorophyll content can be determined partly by hereditary properties of the cytoplasm opens up the possibility that the efficiency of the food manufacturing process in plants may be improved by modification not only of genes, but also of cytoplasmic elements.

A Biologist Says

We Face Uncomfortable Decisions

Raimon L. Beard

Vast areas of this earth still are relatively free from the influence of man. Great mountain ranges, extensive water areas, desolate arctic regions, barren deserts, and dense jungles remain inhospitable to human habitation. Yet in these areas life of different types abounds, and man seems insignificant. Elsewhere broad cultivated fields, irrigated deserts, and flood-controlled river valleys amply demonstrate human ability to provide living requirements. On the one hand, man is arrogant when he assumes he can upset the balance of nature. On the other, the possibility of adjusting the environment to meet human needs places nature in a different perspective. The phrase "upsetting the balance of nature" is frequently voiced in criticism of pest control programs. It is timely, therefore, to examine the concept of the balance of nature and our place in it.

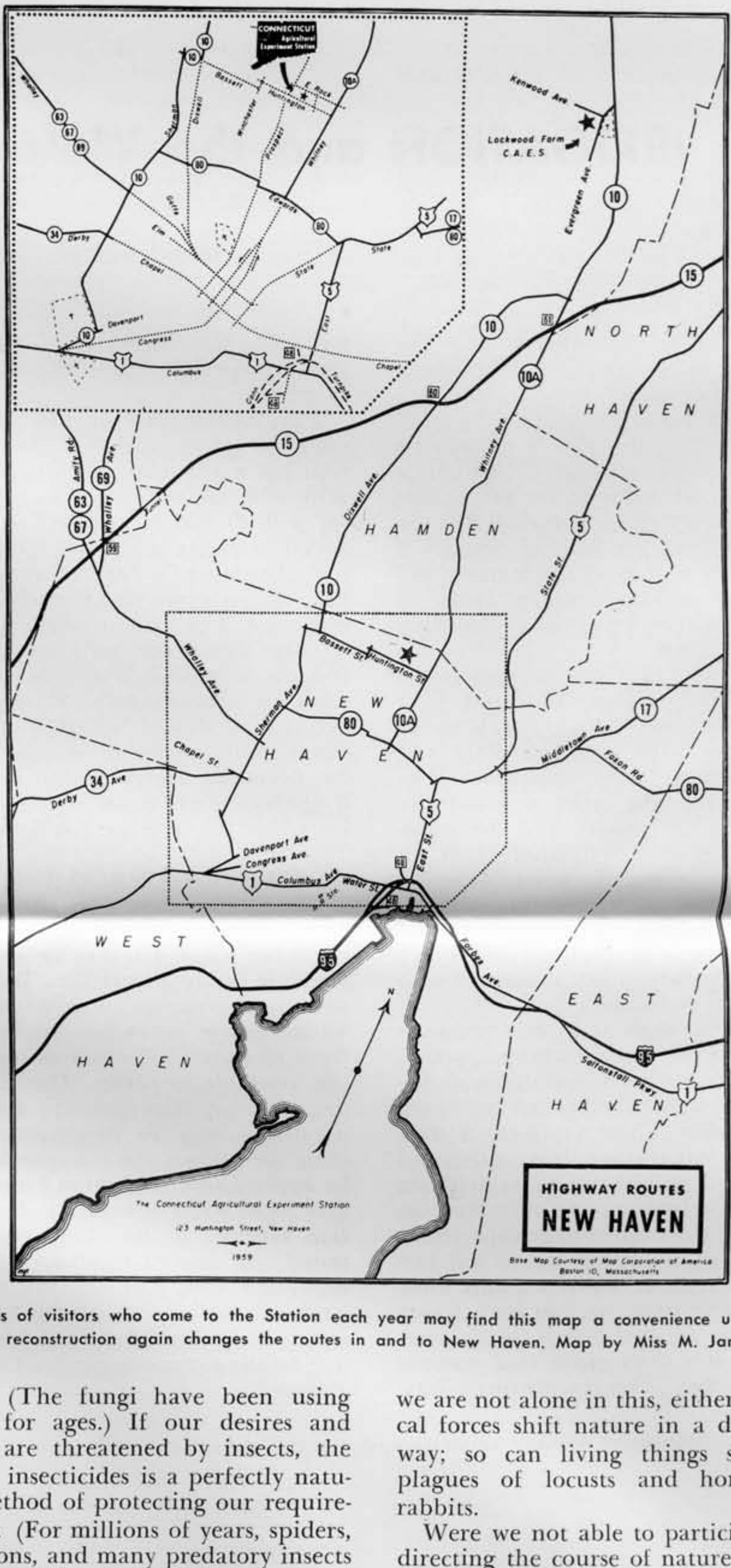


Raimon L. Beard is an entomologist presently at work on the complex problems of insect physiology and toxicology as they relate to resistance. Dr. Beard is a graduate of Wesleyan University and holds the Ph.D. degree from Yale University.

The balance of nature is not simply an abundance of birds, chipmunks, and flowers for us to enjoy, adequate fish to catch, and plenty of ducks and rabbits to hunt. Basically it is the interaction of all life and death. The balance of nature is not a static equilibrium, but an active, adjusting, interdependent, highly competitive, complex system of which man is a definite part.

Life constantly changes, with or without human activity. In New England the bare field, if left uncultivated, gives way to ragweed, goldenrod, and other weedy growth. Brushy vegetation crowds out the weeds, later yielding to red cedar and gray birch. Oaks and hickories or other hardwoods then come in, and their antecedents die out. The trees get big, shade out the wildflowers and bushes, and in their turn grow old and die. At each stage of this moving picture, insect and other animal life is characteristic for that particular situation. Sometimes animal life is active in hastening change, sometimes passive in being affected by the change; it is never completely neutral. The numbers of plants and animals fluctuate widely from season to season and from place to place.

Probably no one believes that these changes and plant-animal relationships are entirely due to chance, helter-skelter, forces. Some early natural historians, being of religious bent, attributed the directive forces in nature



Hundreds of visitors who come to the Station each year may find this map a convenience until major highway reconstruction again changes the routes in and to New Haven. Map by Miss M. Jane Regan.

to divine guidance. Thus the English entomologists Kirby (the Rector of Barham) and his associate, Spence, writing in 1826 said, "An all-wise Providence has proportioned the numbers of each group and species to the work assigned to them." Others have believed that any providential guidance is an indirect one, operating through natural laws.

It was 160 years ago that Malthus wrote: "The germs of existence contained in this earth, if they could freely develop themselves, would fill millions of worlds in the course of a few thousand years. Necessity, that imperious, all-pervading law of nature, restrains them within the prescribed bounds. The race of plants and the race of animals shrink under this great restrictive law; and man cannot by any efforts of reason escape from it."

WE ARE A PART OF NATURE

Malthus' concept of the struggle for existence, which stimulated Darwin's great theory, contains the essence of even modern theories of populations. Malthus' two principal points were that shortage of food is the ultimate, if not the immediate, means of population control, and that man is not excluded from nature in this respect.

The struggle for existence is no idle phrase. The changes in nature are not made harmoniously. Sometimes they result from such catastrophic events as floods, drought, and violent storms; sometimes they result when some organisms crowd out others less fit. Competition is keen—not only among individuals, but among species. Every gardener knows this; his flowers and vegetables cannot meet the competition of weeds without his help. As Malthus emphasized, we, too, are a part of this competition. *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 live successfully in an environment plants and animals must be well-endowed with the properties for living there. 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. If our lives are threatened by disease organisms, it is natural to use antibiotics. (The fungi have been using them for ages.) If our desires and needs are threatened by insects, the use of insecticides is a perfectly natural method of protecting our requirements. (For millions of years, spiders, scorpions, and many predatory insects have used chemicals, their venoms, in getting food and meeting their competition.) This being so, as a part of nature we can scarcely upset the balance of nature, but we can shift it—just as do all other living things. The important difference is the degree to which we can shift it. But we are not alone in this, either. Physical forces shift nature in a dramatic way; so can living things such as plagues of locusts and hordes of rabbits.

Were we not able to participate in directing the course of nature significantly, far more of our population would be starving. As with many animals, shortage of food would long since have limited our numbers just as Malthus predicted. Even at present the population picture differs greatly in the bazaar of an Asian city, in New

(*Continued on page 7*)

IRRIGATION and the Water Budget of Soils

David E. Hill

The ability of a soil to store the precious water required for plant growth determines, in part, the agricultural or forest cover upon the land. An estimate of this ability or capacity is required for efficient irrigation, a practice now followed on more acres than ever before. A knowledge of the available moisture holding capacity of the soil as well as of the manner and speed of moisture release helps us adapt irrigation practices to the needs of crop plants.

Both the available moisture capacity and the release potential have been determined for some soils in the laboratory with pressure plate and pressure membrane apparatus. The methods are time consuming but give most accurate results, and the information can be directly applied. When speed is essential, however, practical estimates of these moisture holding and release characteristics may be made from field estimates and quick tests in the laboratory, evaluated with the aid of established data.

Using the slow and exact pressure-plate and pressure-membrane apparatus, we have determined the available moisture storage capacities of seven soil textures. These represent a wide range of soil texture, from cultivated fields and woodlands. You will see from the accompanying table that the available moisture storage capacity increases as the average size of soil particles decreases. Windsor loamy sand, with coarse particles, can store 1 inch of water in the 8-inch plow zone, slightly less than twice that amount in 18 inches. The fine-textured Buxton silty clay loam has a moisture storage capacity almost exactly twice as great.

The information in this table is ready to go to work for the farmer who has a soil map and some familiarity with the soil types on his farm. He will, of course, realize that water added in excess of the available holding capacity will leach through the soil, taking plant nutrients from the root zone. The rate at which water is applied should be adjusted to soil texture; a soil high in clay and silt takes in water slowly. Surface runoff, if any, should be taken into account. Since moisture storage capacity normally varies within a field, irrigation practices are commonly adjusted to the average condition.

PREDICTION FORMULA USEFUL

Our studies show that silt content and capillary porosity are largely responsible for differences in available moisture holding capacities. Both clay and organic matter increase the total water storage potential, but both of these also "tie up" water so that it is not available to plants. The silt content and capillary porosity are comparatively easy to determine. Once these are known, the information can be applied to a prediction formula to give an estimate of capacity. A prediction formula of this kind has been tested and proved most accurate for cultivated sites. On recently cleared land and on forested sites the formula sometimes indicates an available moisture holding capacity greater than the observed.

Moisture storage capacities of some Connecticut soils

Soil type	Stored in 8-inch plow zone	Stored in top 18 inches of soil
	Inches of water	
Windsor loamy sand	1.0	1.9
Merrimac sandy loam	1.3	2.8
Cheshire fine sandy loam	1.3	2.9
Agawam very fine sandy loam	1.4	3.2
Wethersfield loam	1.6	3.2
Narragansett silt loam	1.9	3.6
Buxton silty clay loam	1.9	3.7

David E. Hill became a member of the staff in Soils and Climatology about 2 years ago. He is a graduate of, and holds a doctor's degree from, Rutgers, the State University of New Jersey.

In determining how water is released to plants, we must realize that some soils hold on to the available moisture more tenaciously than others. Moisture release curves indicate that a loamy sand will readily release two-thirds of the 1 inch of available moisture in the plow zone. A silty clay loam, on the other hand, may readily release only one-fifth of the 2 inches of the available water. So actually the loamy sand may provide readily about 60 per cent more moisture than the silty clay loam, even though the loamy sand has a total available moisture capacity only half as great as that of the silty clay loam.

Coarse and medium textured soils, which warm up quickly in the spring, are commonly used to grow high quality, high cash return crops. They need, and may be able to pay for, more irrigation water in dry periods than do the finer textured soils. Offsetting this, however, is the ready availability of whatever moisture may be in the coarse and medium-textured soils. While not all of the moisture in finer textured soils is easily available, these soils can hold more moisture and do release enough of this water to carry deep-rooted crops through extended periods of drought.

Knowledge as to how water is held and released by soils does not give all of the answers needed in irrigation. We must also recognize the differences in the moisture requirements of crops, the root distribution of crop plants, and the many variables of climate that affect transpiration and evaporation.

Decisions

(Continued from page 5)

York's subway at rush hour, or in Connecticut suburbia. Every four months the inhabitants of the world increase by as many people as now live in New York City. How long we can postpone the time when our numbers will overrun our food supply remains to be seen. More and more we must shift nature in our favor if we are to feed, clothe, house and transport our ever-increasing masses.

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. We know, for example, that it is far easier to reduce populations than it is to eradicate them. We know, too, that plants and animals have remarkable powers of genetic adaptation. But we cannot expect these powers to work in our favor in those organisms we seek to increase and at the same time not work against us in those organisms we seek to destroy.

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.

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.

Entomology

B 619 Laboratory Studies on Housefly Populations
B 621 The Alfalfa Weevil
C 204 The Orange-Striped Oakworm
C 206 Pod Gall of Honey Locust
C 207 The Red Pine Scale

Reports on Inspections

B 616 Commercial Feeding Stuffs, 1957
B 617 Foods and Drugs, 1956
B 618 Commercial Fertilizers, 1958

Tobacco

B 623 Nitrogen Sources for Connecticut Tobacco, 1958

From the Director

Albert E. Dimond, Chief, Department of Plant Pathology and Botany, has accepted the invitation of Director James G. Horsfall to write here a guest editorial. He discusses Chance and the Scientific Method. Dr. Dimond is a graduate of the University of Wisconsin and there received the Ph.D. degree in botany. He has been on the Station staff since 1946. His investigations in chemotherapy of plant diseases and on development and testing of fungicides have been widely recognized.

A. E. Dimond

Pasteur once said that chance favors the prepared mind. He knew that the element of chance cannot be eliminated from the scientific process. Sometimes scientists belittle the role of chance because, after all, the purpose of the scientific method is to reduce the accidental to a minimum. Yet in controlled experiments, unanticipated and accidental things do happen and these, when properly interpreted, may lead to discovery. Chance is indeed an element in successful research, as are Imagination, Inspiration, and Information.

Investigation begins with a question. We all know that a question can be asked in numerous ways, and the answer one receives depends upon how the question is asked. It is the same in scientific investigation. The scientist must think penetratingly about the nature of the problem for which he seeks an answer. He must be sure that he understands it thoroughly, so that he can state it clearly and concisely. His experiments ask a question of nature and he must therefore consider carefully how the question is asked. Defining the problem with precision is a long first step toward accomplishment.

Having done this, the scientist considers other problems that resemble the one at hand. This process of marshalling the known that we may seek the unknown is often made easier when a scientist discusses his ideas freely with his colleagues. Step by step the scientist builds on the foundations others have laid, taking care that he stays on a footing of fact and not of prejudice, pausing now and again to think about apparently unrelated facts that sometimes show the way. Here chance indeed favors the prepared mind. The right idea at this time may bring order to unordered thinking.

Chance favors the mind that is alert to opportunity. At times, while investigating one thing, a research worker observes something quite unrelated. By focussing attention on this chance occurrence and seeking its meaning, a man may make a discovery unrelated to the original subject of investigation. Sir Alexander Fleming, we remember, discovered penicillin in just such a way. He observed a green mold growing on an agar plate used to cultivate bacteria in his laboratory. The growth of the bacteria was inhibited wherever this fungus, *Penicillium notatum*, grew close by. Many people had observed this effect and thought nothing of it. To Fleming, who asked himself the significance of what he saw, an idea was born. Could the *Penicillium* form a substance that killed bacteria? From this chance observation and the reasoning of a prepared mind came penicillin, and, soon after, a wealth of antibiotics.

A discovery may be greater when visualized in broad terms rather than pin-pointed to fit an immediate need. To be valuable, a result must have some application to human wants or needs. To be of incalculable worth, however, a discovery must be valid in many situations; it must light the way toward more complete understanding of a wholly new principle. Such principles can be found as readily when working on specialized problems as when working on those that are abstract. The key to such discovery lies not so much in the nature of the problem as in how it is conceived and how the research is executed. Imponderable chance lends a helping hand more often than we realize. The scientist who prepares his mind for this has recognized an important principle!

Plant Pest Handbook

A second printing of Bulletin 600, Plant Pest Handbook, is now in process. A charge of $1 a copy is made for this publication.

"I Want You to Serve"

Charles G. Morris

Senior member of the Station Board of Control, Charles G. Morris has served 27 years since his appointment by Governor Wilbur Cross in 1932. He writes here on some of the considerations that underlie his long and faithful service on the Board.

What boy is not interested in chemical and many other sorts of experiments? Playing with chemicals and explosives in boyhood has marred the faces, hands, and sometimes the precious eyesight of boys from time immemorial. What boy has not been thrilled to learn of the experiments of old, of Galileo, of Christopher Columbus, of Robert Fulton, of the Wright Brothers, to say nothing of the experiments toward achieving space flight of today or tomorrow? This boy nature persists in men and cannot be entirely outgrown: it has made possible every advance in science and technology.

When I was a boy my older brother's chum, Tom Osborne, and another older boy, Edward H. Jenkins, wore a faint halo or aura because of that undefined, unlimited, and almost magical word EXPERIMENT. They were "keys" to the Experiment Station.

In my early years in the dairy business, the milk industry was experimenting in the use of glass bottles, experimenting in washing those bottles better than the housewives could (or at least did!), and experimenting in development of cooperation and understanding of each other's problems by the farm folk who produced the milk and the business folk who processed and delivered that milk. We were experimenting, too, with the devices and inventions and methods of making and delivering ice cream that was (of course) better than that of our competitors. (That is the best reason that any part of the food industry can give for its activity.) From the beginning we turned to The Connecticut Agricultural Experiment Station for scientific knowledge we needed—yes, craved. Improperly prepared or handled food of any sort might produce illness in those who ate it. And the Experiment Station showed just as much interest as we did in tracking down and correcting any possible human error.

In the middle of my busiest years, Governor Wilbur Cross asked me to serve on the Station Board of Control. I declined the honor. Then, having had a bit of political experience myself, I reconsidered when the Governor insisted: "I want you to serve." And I did.

Although I would feel as safe in finding my way through the African jungles as in finding my way through a laboratory alone, I still find a fascination in getting even sketchy details which are within my competence as to what the Station is doing—daily, hourly, and perpetually—not merely in the laboratory but in the field, such as sampling and testing farm and flower garden soil. This field research is more obvious externally, but the genetics involved in the double cross of hybrid corn by Dr. Donald Jones, for example, is far beyond my grasp.

Dr. Israel Zelitch, Department of Biochemistry, presents letter of appreciation to Charles G. Morris on completion of 26 years as Board member. The letter was signed by all members of the Station staff.

Long ago, the experimental feeding of animals to determine the relative values of different foods gave intelligent direction to the producer's efforts to offer his trade the most perfect milk and the most satisfying and delicious ice cream "in the world." Every new process or procedure, whenever we had any question as to its desirability, we could have studied and evaluated by the Station. I felt then, as now, that the time and thought I had given to the development of the Station and its policies had been well rewarded.

We knew that our competitors had the same opportunity and that the study of our problem was as thorough and as unprejudiced as any human action could be.

It is in this same spirit that I serve on the Board of Control—to help keep the Station on a true course of intelligent inquiry into some of the problems of our wonderfully complex world.

FRONTIERS
of Plant Science

VOL. XI No. 2

FRONTIERS OF PLANT SCIENCE is
a report to the people of Connecticut
on the research of
The Connecticut
Agricultural Experiment Station
in agriculture, forestry, and gardening

Available upon request

BRUCE B. MINER, Editor

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Director

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