PLANT PATHOLOGY IN THE U.S.S.R.

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Introduction

The impressions summarized in this article were registered during a visit to the U.S.S.R., which extended from May 15 to July 28, 1961. I was one of the Canadians fortunate enough to take part in the exchange of scientists between the National Research Council of Canada and the Academy of Sciences of the U.S.S.R.

My itinerary included a week in Moscow at the beginning of the trip, and most of a week just before leaving the U. S. S. R. ; approximately three weeks in Leningrad; most of a week in Kiev; approximately three weeks at Krasnodar in the Kuban region of the northern Caucasus; a week and a half at the Kuban Experiment Station of the All Union Institute of Plant Production, about three hours drive east of Krasnodar; and most of a week at Tashkent, in the Central Asian republic of Uzbekistan.

As I speak Russian, I travelled without interpreters or guides. Because I had no guide to arrange such formalities, I was not exposed to the numerous long-drawn-out sessions of caviar, vodka, and speeches reported by many other visitors. Because I clearly expressed my desire to concentrate on institutions where plant pathology research or teaching is done, I made only one formal tour of a state farm, and visited a minimum number of institutes which were of only peripheral interest to me,

The absence of formal receptions did not imply a lack of hospitality. I was welcomed warmly by scientists everywhere, and shared their laboratory and office lunches, ranging from bread, cheese and tea; through cold cuts and beer; to plov, exotic fruits, and green tea from bowls. I was treated to meals in institute staff canteens, in a neighborhood "militia" canteen, in good restaurants, and in private homes; and was invited to and advised about theatre, opera, and ballet performances.

MOSCOW

Institute of Microbiology.

Dr. E.N. Mishoustin and his group are doing monographic studies on bacteria, fungi, and actinomycetes in the soil, They are particularly interested in the correlation between soil type and the soil microflora, and in at least one applied problem. They explain the increased yields reported as a result of very deep plowing, by the fact that microbial activity is much greater in the top layers of soil than in the lower ones. When the top layers are turned under in deep plowing, they stimulate greater root growth in deeper layers of soil, enabling plants to utilize nutrients more effectively.

Dr. A.F. Protsenko, who has worked on various problems in plant pathology, now concentrates on electron microscopy of the viruses. He has published a handbook (or electron microscope photographic album) of about 60

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viruses, with a classification based in part on morphology of virus particles and on their manner of spread. The album includes a photograph which on the basis of circumstantial evidence, is thought to be of particlee of aster yellows virus from various hosts and dodder.

Main Botanical Garden,

Dr. K. T. Suchorulcov and his group in the Laboratory of Immunity at the Main Botanical Garden provided two stimulating sessions, one during the first week that I was in Moscow and the other in the second visit, just before leaving the U.S.S.R.. The emphasis of the whole laboratory is on physiology of parasitism. They believe that many problems in plant pathology can be solvedonly when plant physiological methods are brought to bear, and conversely, that many problems in pure plant physiology can profitably be attacked using diseased as well as healthy plants.

A great deal of emphasis is placed on biotic factors, or "bacterial vitamins", in relation to resistance and suceptibility, and parasitism and saprophytism. Susceptible plant varieties and plant tissues differ from resistant ones by having a higher content of biotic substances. Highly specialized species or var'ieties of fungi such as Botrytis differ from the less specialized forms by responding to specific biotic materials present in in their hosts, and not to non-specific substances, whereas the less specialized forms respond to a wider range of bacterial vitamins and are not appreciably benefited by specific plant autolysates.

The germination of spores of pathogens has been found to be favoured by the ,greater concentration of biotic substances in infection drops on susceptible as opposed to resistant hosts. This relationship has been found for rusts as well as other organisms. The investigators recognize that spores of virulent races can germinate in infection drops even on resistant plants. My most serious criticism of the generalizations reached in this laboratory, as in a number of others in the Soviet Union, was based on their apparent failure to use known physiologic races and appropriate differential hosts giving reciprocal patterns of resistance and susceptibility respectively, Too many /generalizations on the nature of resistance have fallen down in work in North America, when either the host variety or race of the pathogen was changed, for this factor to be overlooked with impunity.

Other problems which occupy the workers in this laboratory include: Verticillium wilt of cotton; the biochemical and physiological basis of specialization for parasitism in species of Botrytis, members of the Peronosporaceae, the rusts; and pathological anatomy, and the physiology of necrosis. The investigators I met included L.N. Andreev, Elena G, Kling, U. M. Plotnikova, and M.N. Talieva.

Main Botanical Garden,.. Plant Protection Section

.Professor E.S. Cherkassky, an entomologist, is in charge of this section which includes entomologists and plant pathologists, One of their main responsibilities is to control insect pests and diseases of all the plants in the Botanical Garden and in the greenhouses. To help discharge this responsibility, they do research on various insecticidal and fungicidal preparations, on methods and rates and times of treatment, and related practical studies. They also work on the identification of the pests and disease organisms,

and their biology. Staff members present during my two visits to this section included Mmc. E. P. Protsenko, a plant pathologist, Mmc. C. P. Berdenikova, an entomologist, and Miss Levina, an "aspirant", or candidate for a higher degree, also working on entomological problems.

Academician N.V. Tsitsin, Director of the Botanical Garden and a pioneer worker in the production of "perennial" wheat, is as enthusiastic as Prof, Cherskassky about the effecitveness and value of activated creoline (lcryolin?), apparently a mixture of gamma and delta isomers of hexachlorbenzene in "creoline". Mixtures including the delta isomer have pronounced fungicidal effects; they are used as sprays in various concentrations, incorporated into dusts on various inert carriers, etc, The material has been found effective against Plasmodiophora brassicae, against fungi on roses, and, with the gamma iosmer in various concentrations, is effective against a wide spectrum of insects and mites.

Moscow State University, Faculty of Biology and Soils, Department of Lower Plants.

Professor M. Gorlenko, Head of the department, worked as a professional plant pathologist before coming to the university about 1955. Students in the faculty spend two years on basic science subjects, then three years in the specialized faculties. About ten to fiteen students come into the Faculty of Lower Plants each year. In addition, there are six or seven "aspirants" studying for the degree of "Candidate of Science", similar to or perhaps a shade above our Master of Science degree, but not up to the level of our Ph.D.

Professor Gorlenko' s associates include Galina D. Uspenskaya, Ludmila M. Lyovkina, P.V. Kuznetzov, and G.A. Chinov. Their major interest seems to be the evolution of parasitism. They are particularly interested in Cladosporium, Alternaria, and Macrosporium, because they feel that parasitism has evolved relatively recently in these groups. They find that parasites as a group use amino acids in larger quantities than do saprophytes, and that the most virulent forms within a species leave less residual amine nitrogen in a peptone medium. This general finding applies also to Verticillium from cotton, They are also comparing the enzyme systems of parasitic and saprophytic forms within various genera and species.

I had quite an argument on physiologic specialization and genetics of pathogenicity with a man trying to distinguish populations in Ustilago zeae. Everybody took part and everybody seemed to enjoy it.

The people in this group are interested in practical problems, but devote most of their time to theoretical questions, It was stimulating to meet them,

Timiryazev Agricultural Academy, Department of Plant Pathology.

Professor M.S. Dunin is Head of the Department: M. Minyaeva is Associate Professor; and Zoe P. Kochalava, Director of the Plant Protection Station of the Department. They have about fifty students in each of the five years in the Plant Protection course. There are usually eight or nine aspirants working in the Department, and about as many working elsewhere in the U.S.S.R. under the guidance of staff members. It takes three years to get the Candidate' s degree working "internally", and at least four years "externally". The aspirants in 1961 included students from China and the United Arab Republic.

Professor Dunin and his associates are interested in a wide range of problems, theoretical as well as applied. He has developed a hypothesis of phasic susceptibility of hosts to infection; its practical application consists of using cultural practices which will shorten the susceptible or prolong the resistant phases of host development. The staff and their students have investigated the relationship of rusts to the ontogenesis of their hosts; the variability of fungi as influenced by fungicides; and changes in pathogenicity as the result of transfers on a series of host varieties differing in resistance.

Venturia inaequalis cultures developed increased resistance to various poisons incorporated in the medium on which the fungus was grown; this change was not a permanent one, disappearing in a few generations on a normal medium. The reaction of Phytophthora infestans to fungicides could not be changed. The virulence of Puccinia triticina was not changed in repeated single uredospore inoculations on a range of wheat varieties. One culture which increased in virulence on previously resistant varieties also differed in colour; the variant proved to be stable for many generations.

When fibre flax plants were spaced widely, they produced many branches, with primary, secondary, tertiary and higher orders of branching. It was found that seeds from the higher orders of branching produced plants which bloomed later and were much more susceptible to wilt and to rust than plants from seed produced on the primary branches. They have also found that seed of winter wheat, sown on clean fallow to get higher yields, produced plants which were appreciably more susceptible to leaf rust than those from seed produced under less favourable circumstances.

They spoke of some rather interesting work with wheat bunt (Tilletia tritici). Wheat seed was sown in sand with one half of one percent by weight of smut chlamydospores added; seedlings transplanted from the sand to the field were often free of smut and the plants showed greater vigor than normal. The smut spores apparently produced some active substances, neither auxins nor gibberellins, which stimulated germination of spores of other species, as well as development of wheat plants. Similarly, extremely heavy doses' of smut (Ustilago zeae) applied to the silks of corn plants counteracted the adverse effects of selfing, increased seed set on selfed cobs, and gave rise to light or no infections of smut. Similar effects are now being sought from extracts made from smut spores.

They are also working with viruses. One project involves producing active antisera for determining virus infection. They have had success using antisera of very high titre, from 1:1000 up to 1:20,000. They claim that this compares with titres of from 1:60 up to 1:100 used in Europe and the U.S.A. Apparently, the method of preparation of the sera is vital in attaining this high level of efficiency. Another line of work is to try to determine "pro-virus" comparable to "pro-phage". Tests of potatoes with antisera at harvest time have shown them free of virus; in the spring, tests with the same sera indicate the presence of virus. As they were not able to prove infectivity of the antigenic materials, they may have found the "pro-virus" they were seeking. They could not confirm the "de novo" origin of virus in plants reported by colleagues.

Professor Dunin is a veritable dynamo of energy and ideas, and is apparently appreciated by his colleagues at other institutions as well as his own. There was a large and elaborate celebration of his sixtieth birthday, to which I was invited. Unfortuntely, my arrangements had already been made to leave Moscow the night before the celebration, so I was not able to attend.

LENINGRAD

Botanical Institute of the Academy of Sciences.

The people I met at this Institute were all specialists on the taxonomy of various groups of plants. Dr. A.S. Bondartsev, well over 80 years old, is an authority on wood-destroying fungi. His daughter, Margarita A. Bondartseva, is working for a higher degree on the polypores and related forms, and handles the correspondence and much of the work for her father. Vasilkov works on Agaricales; Tomilin works on the Ascomycetes; Nikolayeva works on the Thelephoraceae; Dr. P.N. Golovin is currently working on a monograph of the Erysiphaceae, but his interests embrace most of the groups of fungi, and his experience includes a great deal of work on plant diseases, including Verticillium wilt of cotton in Uzbekistan. He has written a book on the fungi of sand deserts of Central Asia. He found tens of species of Peronosporaceae in the desert sand, and believes the area to be an evolutionary center for this group.

Dr. Golovin works with herbarium material. His distinctions of species and higher categories are based on morphology, ecology of the fungi and their hosts, and distribution. He has students working on various groups of fungi in scattered regions of the U.S.S.R. Like him, they are interested in evolution of the fungi, their phylogeny, geographical relations, and ecology. Presumably, they also follow his lead in being "splitters'"

All Union Institute of Plant Protection (VIZR).

This Institute, which operates under the direction of the Academy of Agricultural Sciences, has about twenty specialized stations scattered over the Soviet Union, varying in size from two to three people up to four hundred or five hundred staff members. It sends expeditions to those areas where it has no stations of its own.

The Institute is not a teaching organization, but it has about sixty aspirants in all fields, about twenty of them in plant pathology. They carry on regular work as staff members of the Institute, and defend their dissertations for the Candidate of Science degree at various teaching institutions. The Institute has its own "Learned Council" before whom doctoral dissertations can be defended. The library is large and quite complete in its field, with an exceptionally full and efficient index and catalogue.

The Institute consists of a large number of specialized laboratories, varying in size of staff. The Director of the Institute, I.M. Polyakov, is also in charge of the Laboratory of Phytotoxicology. The Acting Director of the Institute, E. Shumakov, is an entomologist.

The Mycology Laboratory, headed by Professor M.K. Khokhryakov, works on biology of pathogenic fungi, and only incidentally on their taxonomy. It has available an herbarium with over 16,000 species of fungi, with a card index to each accession, which actually works; there are also cultures of about 300 pathogenic: fungi and about 300 saprophytes. The laboratory receives a large correspondence and many specimens; its staff is required to do considerable diagnostic work and give advice on disease control to collective and state farms. They also turn out handbooks on diagnosis and control of diseases. Although there is at least one "splitter" on the staff, Professor Khokhryakov is

a "lumper" in the best tradition. Current problems include, among others, dwarf bunt of wheat and grasses; Plasmopara halstedii on sunflowers; Fusarium oxysporum on legumes and other hosts,,

Various groups within the institute are currently very much concerned about Peronospora tabaci, which has already invaded the western part of the U.S.S.R., near the border of Czechoslovakia, They are very much afraid that it will spread.

S.V. Andreev of the Laboratory of Biophysics had a pilot model of a new small "phytotron" under production in a factory. One hundred similar chambers had already. been ordered for distribution to various institutions. It is three metres long, two metres wide, and two and a half metres high. It is an extremely versatile piece of equipment, permitting programming of light intensity up to 40,000 lux; temperature from -5° to +60°C; relative humidity from 23 to 98%; all regulated by studs which can be set in any of a large number of holes on the surface of a revolving disk, It is expected that the factory models will cost approximately 25,000 rubles (between $27,000 and $28,000).

It is quite possible that the cabinets will work and will do what their designer expects of them, but they seem unduly elaborate and expensive for most uses. There may be some point to so versatile a cabinet for someone studying the desigh of growth cabinets. In most research applications, however, it would be simpler and cheaper, and at least as satisfactory, to have a series of cabinets, each with a much more limited range, to cover the various possibilities included in this one extremely expensive machine.

G. M. Shkarlat of the Laboratory of Biological Methods (Biological Control) has small growth cabinets about 30" by 30" by 30", with no control of relative humidity, weak light, and controlled temperature (for entomological use, not for growing plants). Six new cabinets are being set up with much more elaborate control of temperature, relative humidity, and photo period, although not light intensity.

The Plant Pathology Laboratory, headed by Professor S. M. Tupinevich, is particularly concerned with diseases of vegetable crops and of potatoes. Cultural controls for these diseases are worked out in detail by the Laboratory of Agrotechnical Methods. According to one of the pathologists, in some greenhouses producing cucumbers on a small scale, Fusarium wilt is controlled by seeding cucumbers in the same pots with pumpkins or other resistant cucurbits, and grafting the cucumber onto the resistant species. This method is too laborious to be used in the larger greenhouse enterprises, some of which are large indeed! Plasmopara halstedii on sunflowers is sufficiently important that both a mycologist and a plant pathologist are working on the disease.

The Laboratory of Phytotoxicology tests chemicals which it gets from VIZR's own Laboratory of Organic Chemistry, from the Institute of Insecticides and Fungicides, the Institute of Organic Chemistry, and the Institute of Applied Chemistry. They are particularly interested in apple scab and late blight of potatoes. Promising chemicals selected by screening under laboratory and greenhouse conditions go to experimental fields at Pushkin, not far from Leningrad, and to experimental stations at various other points. There are 45 stations distributed throughout all zones of the U. S. S. R. where toxicological tests are made. The laboratory also investigates all new agricultural pesticides on behalf of a government commission.

The Director of the laboratory is trying to confer chemical immunity on plants by the use of various seed treatments and spray applications. Work is

also being done with soil fungicides and fumigants, to control Plasmodiophora brassicae, Rhizoctonia aderholdii on cabbage, and Fusarium oxysporum. They are interested in the effect of the soil treatments, including fumigants, on useful microflora, such as Trichoderma; in minimal effective dosage; and the influence of soil type, moisture, and temperature (some sterilization in cold frames has to be done when day temperatures are 18°C and night temperatures 2°C).

The Laboratory of Immunity, headed by Professor Fedotova, works on diseases of interest to the whole country, such as rust of wheat, loose smut of cereals, late blight, .wart of potatoes, and wilt of cotton. Disease problems of local concern are studied in local institutions. The laboratory has its own stations in various zones of the U.S.S.R., and cooperates with similar laboratories in institute's of plant protection in the various republics.

One objective in the work with late blight is to find new rapid methods for evaluating resistance, to be used at plant breeding stations with limited facilities. Tests are made on etiolated shoots, permitting selection of tubers before planting without loss of planting material. Differential effects corresponding to the effects of various race5 of the blight have been obtained with toxins produced by Phytophthora, which are stable, give quick results, and can be sent to outside stations.

Professor Fedotova believes that resistance in many cases is a property of the host protein; susceptible varieties have weak protein structure. She and her many associates have worked out serological tests which permit clear cut determination of the resistance of varieties to late blight. She claims that she can predict the reaction of varieties of cotton by using antisera prepared from various races of Verticillium, and the globulin fraction from cotton seeds; susceptible varieties produce a precipitate, resistant ones do not. She has also found that the leaf temperature of susceptible varieties is higher than that of resistant varieties in the absence of infection; when plants are infected, their temperatures increase.

Potato wart was brought into western U.S.S.R. by the German armies, Every effort is being made to keep it quarantined, and also to develop resistant varieties. By law, no new variety of potato may be released unless it is resistant to wart. Many apparently resistant varieties with no external symptoms carry Synchytrium in the cells. When the organism was isolated from such tubers and inoculated to a series of weakly resistant varieties, it began to produce symptoms even on the varieties formerly thought resistant,

The Laboratory of Prognosis, headed by A.E, Chumakov, is one of the largest in the Institute. It is responsible for predicting the areas and expected degree of infestation with such general pests as rodents and other warm-blooded animals, grasshoppers, and insects and diseases of various crops such as cotton, cereals, sugarbeets, and the other important field, forage, vegetable, and orchard crops. Tentative forecasts are made half a year in advance for the benefit of the Ministry of Agriculture of the U.S.S.R. and of the fifteen republics. The laboratory is also supposed to recommend new ideas in cultural practices and new chemicals to be'used in control, as reported in the literature, It has about one thousand regional reporting stations scattered throughout the Soviet Union. There are usually two or three people, an entomologist, a zoologist, and a pathologist, at each point. In the drier zones there may be only one person sending data to the central laboratory, The fifteen hundred crop variety testing stations operating under the Ministry of Agriculture also send data on

diseases and pests to the Laboratory of Prognosis. Full reports are made in October, and short reports every two weeks if anything unusual develops. The laboratory prepares a detailed prognosis for release in late winter, The forecasts are used by planners to decide what equipment and chemicals will be needed in various areas. Booklets giving the prognosis are published for the U.S.S.R. and also by the Russian S.S.R. Other republics hope to start publishing their own prognoses fairly soon.

The recommendations are worked out in greater detail for specific regions in the respective republics, sometimes bringing them down to specific state and collective farms, Detailed short term forecasts are made at the approximately one thousand prognosis points throughout the Soviet Union. They provide spray warnings, etc.

The central laboratory is concentrating on better methods of making short term and also long term forecasts for the rusts, The mathematics involved is fairly complicated, as they are attempting to reduce all the factors involved to a single numerical index.

One interesting method of control for Puccinia glumarum in the foothills of the Caucasus, which I heard about in this laboratory, is to use seed of the same variety produced in the steppes, about 200 kilometres away. The conditions under which the seed is formed are believed to be vital in determining the reaction of plants to the rust.

University of Leningrad, Department of Mycology.

Professor V. Y. Chastukhin, is a specialist in industrial mycology. We is primarily interested in the decomposition of forest vegetation, and in the physiology of pure cultures of wood and leaf decaying fungi. He has managed to get 90% utilization of leaf material by using an appropriate succession of fungus species in lab cultures, He is also trying to produce protein from industrial wastes, in order to get animal feed proteins. His big problem now is to produce spore material for "sowing" the tanks used in the continuous deep tank process for large scale production. Students in this department work on systematic mycology, on algology (Professor V. S. Shetukova-Poretskaya is an algologist who has published monographs on fossil diatoms); the undergraduate students do their "diploma work" and the aspirants do their theses in systematic mycology and algology, ecology, and physiology,

All Union Institute of Plant Production (VIR)

Academician S. M. Bukasov, potato breeder, and Dr, V. S. Lekhnovich, specialist in systematics and history of potatoes, have a tremendous world-wide collection of potato species and varieties. They have the German differentials for distinguishing Phytophthora infestans races 1; 2; 3; 4, singly and in all combinations, but none for race 5. They were very interested in obtaining Canadian differentials'.

PUSHKIN

Agricultural Institute, Faculty of Plant Protection, Department of Plant Pathology.

Professor T. L. Dobrozrakova and her five associates in Plant Pathology have about fifty students in each of the five years of the plant protection course. They also teach plant pathology to students in other courses. They expect to

accept about 75 students per year in future. They also have a large extra-mural enrolment, of students who work throughout the Soviet Union, and come to the Institute for about one and a half months per year to do very intensive laboratory work and to take examinations. Their investigational work is on plant diseases important in the Leningrad area, particularly diseases of small fruits, and of greenhouse and field vegetables. Plasmodiophora brassicae is still a problem on cabbage, which is grown on a large scale, sometimes hundreds of hectares in one field, Most af the studies are practical, such as the effect of fertilizers and of resistant varieties on the development of the disease, They also do some basic biological work, such as trying to determine the biochemical basis for the tolerance of some varieties of cabbage to clubroot.

I was permitted to attend an all day examination in which eight students in the fifth year of the Plant Protection Faculty "defended their diploma work". The respective topics, which may or may not have been completely representative, were as follows: (1) A report on the synthesis of six different phenolic compounds, using various methods; their purification and characterization; and a study of their effectiveness as insecticides on various orchard insects, relating their insecticidal properties to their chemical structure. (2) Studies on the ,control of Phytophthora on potatoes and tomatoes, using new fungicides, determining effects on infection and yield, and toxicity to spores. (3) Control of Phytophthora of potato, using micro doses of copper materials mixed with the insecticidal sprays which are compulsory for potatoes in the Leningrad area, where Colorado potato beetle is present. (4) Tests of fungicides to control powdery mildew of gooseberry. (5) A study of several new antibiotics against eight plant-pathogenic fungi, including leaf pathogens and also storage rot organisms. (6) Control of 'Sclerotinia or greenhouse cucumbers, using various chemicals and cultural practices, and studying the ability of the pathogen to survive in soil free of vegetable debris, (7) The taxonomy and biology of several rootfly maggots (8) Studies on the control of cabbage fly.

With one exception, each of these projects had been carried on for two summers, as well as taking a large part of the student's final year. Each was criticized and "attacked" by an examiner appointed for the purpose, and each was defended by the professor who directed the work as well as by the student concerned,

Virology Laboratory of VIZR

The Virus Station of the Leningrad VIZR had been established only a year and a half earlier. Two additional stations were started in 1961. Main objectives include working out quick chemical methods of diagnosis for two virus mosaics of cucumber, and the production of virus free potato seed stocks, They are trying to develop a quick method of diagnosis, using serology. One of the problems is that early varieties give non-specific reactions. Apart from some classic studies on virus, very little work on viruses has been done. A great deal of attention is now being paid to viruses, and intensive work is being started on many problems.

Laboratory of Immunity of VIR

This group working at Pushkin has objectives different from those of the Laboratory of Immunity of VIZR at Leningrad. They make intensive, large scale studies on varieties which appeared resistant in the various plots of the

Plant Production Institute (VIR). The Pushkin group uses artificial infection to determine varietal reactions under severe conditions. They work on methods to be used in large scale inoculations, as well as trying to find materials which can be used as resistant parents in the production of new varietics. Thcy are investigating the inheritance of resistance, and are trying to determine the nature of dominance of resistance where it occurs. They are working on leaf and stripe rusts of cereals (stem rust is important only in the far eastern portion of Siberia). They are also interested in smuts of corn and cereals, and Phytophthora of potatoes and tomatoes.

KIEV

Institute of Microbiology of Ukrainian Academy of Sciences

Academician Drobotko, in charge of the Laboratory of Pathogenic Microorganisms (Human Diseases), is Director of the Institute, which is a complex one with many specialized laboratories.

Laboratory of Variation of Microorganisms, Professor T. I. Vizir

The current work of the laboratory is on bacterial transformation by DNA, and efforts to see if other cell constituents can also act as transforming agents. A group is working on variants induced by radiation; they will soon become a separate laboratory. A biochemist working in the laboratory isolates the DNA they use in their transformation studies, and also investigates the specificity of DNA in various species of bacteria and transformed isolates. She has found variation in the DNA, The work is largely with intestinal bacteria,

Bacterial Diseases of Plants, Dr. Beltikova.

This laboratory concerns itself primarily with new bacterial diseases, and those in which new work is needed. One of their main problems is to develop control by antibiotics. Their requirements include not only control of the pathogen, but also stimulation of plant growth and yield. Dr. Beltikova is particularly interested in seed treatments. She believes that antibiotics improve the physiology of the plants, and increase their resistance to disease and winter killing even in the second and subsequent generations. She is also interested in naturally occurring antibiotics of higher plants, and believes that resistant varieties have higher contents of such antibiotics than do susceptible ones.

Apparently, tomato seed for several thousand hectares (quick mental calculation, subject to error), was treated with antibiotics for the control of disease and stimulation of plants. One of their main difficulties is the production of appropriate quantities of material on a factory scale. The production of the antibiotic for the treatment takes most of the time of her laboratory staff, so that they have to neglect their studies on the nature of resistance, etc.

The requirement that a new antibiotic should stimulate plant growth as well as kill pathogenic bacteria seemed to me to be an unrealistic criterion. When I discussed this problem in another laboratory, it was suggested that the stimulation observed was possibly the effect of secondary substances in the crude preparations of antibiotics used in agriculture, and was not necessarily an effect of the antibiotic itself.

Plant Virology, Professor S.N. Moskovetz

The laboratory is concerned with general virology, the properties of viruses, and their effects on plant physiology. They are starting to work on virus diseases of potatoes, which are attracting increasing attention throughout the Soviet Union. Sugarbect yellows is also an important problem, which was not known in the Ukraine before 1956.

Professor Moskovetz had previously worked on cotton diseases in Azerbaijan, where he found virus leaf roll attacking only the best varieties of cotton, A large group working on the problem in the Institute of Cotton Hesearch developed antisera for determining varietal reaction, and succeeded in breeding resistant varieties of good quality in six years. They also studied the effects of various cultural practices on the development of the disease and on its transmission by vectors and by seed.

Mycology Division, Professor N. M. Pidoplichko

At one time this laboratory studied the fungus flora of seeds, and pathogenic fungi, and those which were toxic to man and animals. For the last ten years, they have been working on the mycoflora of soils. Currently, they are working on forest soils and the relation of the mycoflora to agricultural crops. Professor Pidoplichko is a systematist who uses ecology and physiology as well as morphology in his systematic work. In addition to his work with plant pathogens and toxicogenic fungi, he has studied antibiotics. Together with Dr. V. Bilai, they found microcidin, which is effective against both gram negative and gram positive bacteria, including the TB organism.

Division of Fungus Physiology, Section of Biologically Active Substances, Professor Vera I. Bilai

Professor Bilai, recently elected a Corresponding Member of the Academy of Sciences, an authority on taxonomy of Fusarium, is studying antibiotic substances isolated from rhizosphere fungi, for their effectiveness against plant pathogens. They are also checked for medical uses. She is now interested in the taxonomy of Trichoderma, and in some volatile materials which it produces that are antibiotic. Trichodermin has been used against several plant pathogens.

She has found that many strains of Fusarium moniliforme produce gibberellins, particularly when extracts of corn plants in the five to six leaf stage are added to the cultures. She has isolated pure cultures of F. moniliforme from vessels of healthy corn plants. These isolates produce gibberellins, particularly when isolated from corn plants in the younger stages. They may have some role in the normal growth of corn.

Dr. Bilai attended the International Botanical Congress in Montreal in 1959, where I acted as interpreter for her and Dr. W.L. Gordon when they discussed Fusarium. I was greeted like a long lost friend when we met in her laboratory!

Agricultural Academy of the Ukrainian S.S.R., and Ukrainian Institute of Plant Protection.

The Institute works on such general problems as control methods, and also on particularly important and dangerous pests and diseases. It does not work on diseases and pests of specific crops; the various specialized crop institutes all have their own divisions of plant protection. The Institute

has ten specialized laboratories, organized on much the same basis as the laboratories of VIZR at Leningrad. Problems of particular importance in the Ukraine are the sugarbeet weevil, and Peronospora tabaci.

The Plant Pathology Laboratory works on wheat leaf rust, corn smut, Peronospora tabaci, and potato viruses, among other problems. The virus problem on potatoes is particularly severe. The "super elite" stocks have up to 80% virus infection. They are trying desperately to clean up the elite stocks, which have several different viruses in them. They have already developed an antigen for a local strain of virus X, and are now working on sera for two more viruses; they hope to have them within a year. They also hope to develop polyvalent sera in the next year or two.

The visit to this Institute was particularly rewarding because I met Maria Zelle, who worked on sunflower diseases up to 1939, and whose work I had seen only in abstracting journals before corning to the Soviet Union. She had encountered many of the problems on Sunflowers which still interest me, and we were able to discuss in detail work which each of us had done and which neither of us has yet published! She has worked on forest pathology, and on diseases of vegetables, since 1940. Although she is about 75 years old and retired, she comes to the laboratory quite frequently.

On my last day in Kiev, I spoke about "Plant Pathology in Canada" to a joint meeting of the Microbiological Society, and the Mycology and Plant Pathology Sections of the Botanical Society. The meeting sent greetings and best wishes to the Canadian Phytopathological Society, which I transmitted by telegram to the Annual Meeting of the C. P.S. in Regina.

KRASNODAR

All Union Institute for Research on Oil and Essential Oil Crops (VNIIMEMK)

The various sections of this Institute work on a wide range of crops. The most important include Sunflowers, flax, mustard, castor bean, and on a smaller scale, peanuts and sesame, and essential oils. It has sections on plant breeding, soil management, plant protection, and other specialized activities. The breeding program on sunflowers, under Academician V. S. Pustovoit, has been phenomenally successful; the results with flax have also been very good. In 1912, when sunflower breeding was startedat the Institute, the best sample of seed collected from the whole country yielded 33% oil on a whole seed basis. A variety with 35% oil was released in 1925. The best selections, not yet released, now contain well over 50% oil in the whole seed; commercial seed at the factories yields over 40% oil.

The present varieties are resistant to broomrape (Orobanche cumana), seed rnaggot (Hoineosoma nebulela), and are reasonably resistant to rust (Puccinia helianthi).

Hybrids resistant to downy mildew (Plasmopora halstedii), a disease which has appeared in the Soviet Union since 1950, are being produced from crosses with Helianthus tuberosus, which also contributes immunity to rust. Crosses have also been made with the wild Helianthus annuus of Texas, (which is used as a source of rust resistance in Canada), but the progenies have not yet been released as varieties.

The main disease of flax in the area is wilt (Fusarium oxysporum f. lini). Some new selections, not yet released, are resistant to wilt and contain up to 48% oil.

The sunflower and flax breeders use the standard disease nursery techniques to test their materials for reaction to broomrape, downy mildew, and flax wilt, respectively, although their actual breeding methods are different than those used in North America. They depend on natural infection for rust.

The Plant Protection Laboratory of the Institute was established fairly recently, and is staffed by young people. They have started work on a range of problems, but have not yet had time for any major contributions.

All Union Tobacco Research Institute

This Institute has as its objectives the raising of yields and quality, and lowering the cost of production of tobacco (Nicotiana tabacum and N. rustica). Plant breeding is the main method used to achieve these objectives. Although the breeding is based on Michurin genetics, the plant breeders use inter-specific crosses and other classic approaches in their work, The genetics of resistance to disease, cytology, and other theoretical aspects of plant breeding are also studied. Accomplishments include the production of varieties immune to powdery mildew and to tobacco mosaic virus; about 30% of the tobacco area is sown to such varieties. Some varieties resistant to Thielaviopsis basicola have also been produced.

The Plant Protection Section works on many of the 25 plant diseases, mostly viruses, which affect either seedlings or field plants or both in the tobacco regions of the U. S. S. R. They are concerned with identifying the viruses and their vectors, and working out cultural or chemical controls until such time as resistant varieties can be produced. They study races of T. basicola, and soil treatments to control it and other diseases in seed beds. They have worked out methods of inoculation for various viruses in order to test the reactions of selections, and to determine disease effects; they also inoculate soil plots with T. basicola, broomrape, and other pathogens to study the respective troubles which they cause.

The Institute has experimental stations scattered thrsughout the tobacco growing region of the U.S.S.R. Each of these stations has its own plant protection laboratory, working on diseases important in its area.

Agricultural Research Institute

Academician P, P. Lukyanenko breeds winter wheat for yield, quality, and disease resistance. Stem rust has not been severe since the war, although there was a destructive outbreak on winter wheat in 1936. Stripe rust is severe about three times in ten years on the average. Leaf rust is a limiting factor in winter wheat production, He obtains resistant varieties for his crossing program from the world collection, Soviet wheats were not resistant to leaf rust. All the Argentine varieties were resistant to leaf and stripe rust in his area. Unfortunately, there seems to be a negative correlation between leaf rust resistance and quality, so he has used back crossing to incorporate resistance in varieties with desirable quality. He is using the western Canadian variety, Selkirk, in his breeding program, because it combines high quality with resistance to leaf and stripe rust, and powdery mildew. It was free of mildew the previous year in a very heavy outbreak.

The winter wheat varieties released retain ther rust resistance for a relatively short time. Selection for rust resistance is based on natural infection in the field, and apparently tests are not made with specific physiologic

races of the runt. One of the major difficulties, recognized by the wheat breeder is that the limited studies on rust races which have been made helped only to explain the breakdown of previously resistant varieties. He envied western Canadian wheat breeders the service given them by pathologists who keep a close check on the occurrence of rust races, and warn them of changes in the race pattern which may necessitate the incorporation of new sources of rust resistance in the breeding program.

Kuban Experiment Station of the All Union Institute of Plant Production

The main work of this station is to maintain for the All Union Institute (VIR) the varietal collections of those crops which grow well in this area. There is also a limited amount of breeding work done with flax, corn, chickpeas (Cicer arietinum) and one or two other crops. There is no pathologist permanently located at the station, although an effort is being made to obtain one. A wilt nursery is being used in the flax work, apparently in spite of opposition some years ago. Disease resistance of other crops has been determined exclusively on the basis of natural infections, with the almost inevitable result that varieties selected in years with little disease have proven extremely susceptible when conditions were favourable for disease development.

My main interest at this station was the work on Plasmopara halstedii done by N.N. Novotelnova, a pathologist from VIZR at Leningrad, who does her field work with the disease here. I was favourably impressed by her studies on the biology of the organism, although I questioned the basis of her taxonomic treatment of the pathogen.

By coincidence, my room mate in the guest house at the station was Dr. P.A. Lubenetx, who was one of the Soviet scientists who visited the Winnipeg Plant Pathology Laboratory in 1957. He was completing two weeks work in the station plots of forage legumes, which are his main interest.

TASHKENT

Tashkent Agricultural Institute

The Institute has a Faculty of Plant Protection, with Departments of Plant Pathology and of Entomology. The major crops of the area include cotton, fruits, and forage. Fusarium wilt of cotton appeared in Uzbekistan in 1938, and rapidly spread throughout the whole area. Control was achieved by the development of resistant varieties, from crosses between the local fine cottons and resistant Brazilian and Peruvian types. Resistance is determined in a wilt nursery which contains a mixture of virulent races. Verticillium wilt of cotton, earlier brought under control by the distribution of resistant varieties, is again becoming severe where monoculture is practised. A new law requires that cotton be grown for only five or six years, followed by alfalfa for three years.

Uzbek Institute of Plant Protection

The Institute started as a laboratory devoted to cotton diseases and pests in 1912. Since then it has variously been the Uzbek station for Plant Protection, a Cotton Disease Research Station, and a section in the Cotton Research Institute, until it assumed its present role under the Uzbek Ministry of Agriculture in 1957, It is now responsible for work on all crops

in the area, but the main effort is still on cotton. The Institute has the usual series of specialized laboratories and sections; because of its special problems, these include a Wilt Laboratory, and a Laboratory of Immunity, which concentrates on breeding for resistance to wilt. There are about two hundred people working in the Institute, and at its experimental station in Ferghana Valley, where field work is done on cotton wilt,

Fusarium wilt is the main problem on Gossypium barbadense, and Verticillium wilt on G. hirsutum. Projects of the two-year-old Wilt Laboratory include studies on the distribution of wilt; the variability of the causal organisms; the possibility that Verticillium may begin to attack G. barbadense, and Fusarium, G. hirsutum; studies on the biology of the pathogens and development of the disease; methods for early recognition of resistance of cotton to wilt; and methods of cultural and chemical control of wilt.

General Comments

There is a great amount of descriptive work being done in plant pathology and mycology in the Soviet Union, and there are monographs and handbooks on an impressive list of subjects. The research work at the universities and at institutes and laboratories under the Academy of Sciences includes such topics as the physiology of parasitism, the evolution of parasitism, the systematics of non-economic groups of fungi, as well as of plant pathogen.;, The quality of the work varies from place to place and from person to person, as might be expected anywhere. The research at the institutes of the Ministry of Agriculture, and at the institutes and faculties of agriculture, tends to be applied to a greater extent, more so than in some of the laboratories of the Canada Department of Agriculture. The applied work helps to produce more food for more people on a smaller area, and its role is recognized and appreciated.

Most of the laboratories I visited were located in old buildings and were extremely crowded. In several cases, they expected to move to new buildings which were either under constructionor were soon to be built. The equipment I saw was fairly standard in most cases, Some had been imported from Germany, Czechoslovakia, or other countries. Most of it was made in the U.S. S.R. One piece of equipment which I had not previously seen used by mycologists, was a comparison microscope which made it possible to examine two preparations simultaneously in one field of view. My previous knowledge of this equipment was confined to reading of its use in ballistics and fingerprint work. Although laboratory space was restricted in most places, the area in field plots was often very extensive. Facilities for making chemical determinations, such as the oil content of sunflower and flax seeds, and the quality of linseed oil, are available to plant breeders on a scale not matched in Canada.

The universities train relatively few students in plant pathology and mycology, and there are also relatively few graduate students in these departments of the universities. Large numbers of students are trained in plant pathology and plant protection at the institutes of agriculture and the faculties of agriculture. There are approximately 250 graduate students in **the** faculties of **plant** protection at the Timiryazev Academy in Moscow and also at the Agricultural Institute at Pushkin near Leningrad. The **fifty** or *so* students graduated at the end of the five year course at each of these institutions are riot plant pathologists in our sense, but agronomists trained **in** plant pathology

or other phases of plant protection. They are trained to take over any one of a number of duties on a state or collective farm.

A significant number of the graduates from the agricultural faculties return to work as "aspiranti" to qualify for the degree of "Candidate of Science", something between the levels of our M.Sc. and Ph. D. degrees, It involves no course work, but the students do have to pass a certain number of examinations, and must prepare and defend a dissertation in public after about three years work. A small proportion, between 1 and 2% of the Candidates, go on to do research for a dissertation which also must be defended in public, for the degree of Doctor of Science, comparable to the British D. Sc,

Undergraduate training takes five years, both in the universities and in the' institutes of agriculture. Students compete very intensively for admission to institutes of higher education. Education is prized in its own right, but it also gives prestige and social and financial advantages. The entrance examinations are very stiff; once accepted, however, students receive a stipend, pay no fees, and pay only a nominal price for board and room.

The first two years of the course are devoted to such basic subjects as general biology, zoology, botany, chemistry, physics, mathematics and a foreign language, In the final three years, the students work intensively at specialized courses. They are required to spend part of each summer at biological field stations, teaching and research stations operated by the institute or faculty, and on collective or state farms, all in a definite. sequence, and according to a prescribed plan. In the last two summers,' they start to accumulate materials and data to make experiments for the "diploma work" which they have to write up and defend in an oral examination at the end of th of their final year.

The course work is more theoretical and the diploma projects and examinations are even more difficult in the universities than at the institutes.

The organization of the system of higher education is such that the students can be required to work hard. The method of admission into the universities and institutes is such that the students are in most cases'capable of fulfilling the academic demands made of them. It would be very interesting to arrange an exchange of graduate students in plant pathology between institutions in the Soviet Union and in Canada, if there were Canadian graduates in plant pathology with an adequate knowledge of Russian and Russian graduates with an adequate knowledge of English for such an exchange, I suspect that the Soviet students just starting graduate work would be better prepared than Canadian or American students at the same stage.

The people in the institutes, faculties, departments, and laboratories I visited, without exception, were extremely friendly and hospitable and eager to discuss their work and to compare their problems with ours in Canada. They were also very generous with their gifts of books and reprints. They have been very helpful in sending publications which I have requested since returning to Canada and have been extremely appreciative of the reprints of Canadian publications which I have arranged to have sent to them.

One of the objective6 of an exchange of scientists between Canada and the U.S.S.R. is to establish personal contacts between people in related fields of work. In furtherance of that objective, I will be pleased to provide any additional detailed information I may have, and to establish direct contact between any interested Canadian plant pathologists with their opposite numbers in the U.S.S.R.

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