Research
FOR FARMERS

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CANADA DEPARTMENT OF AGRICULTURE

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Cover Photo: **Rapeseed contains over 40% oil. A $10 million crop, the search for new types of rape oil continues.** ***Inset:*** **Rape plant grown from half a seed.** **(See story p. 6.)**

NOTES AND COMMENTS

Shipping fever, or more accurately broncho-pneumonia, is perhaps better known to some as stockyard's pneumonia. In his article on page 3, Dr. Carter reports that the disease is seen in its most spectacular form in the feeders and stockers shipped to Ontario from Alberta and Saskatchewan during the late fall and early winter. The disease may develop enroute and several dead animals may be found on arrival at the stockyards. "Every effort should be made," says Dr. Carter, "to keep Western cattle completely separated from the native stock on the same premises. The greatest economic loss results not from deaths but from loss of condition and weight." At the Animal Diseases Research Institute, Hull, Que., a serological classification of the pasturella strains recovered from cattle with shipping fever is being carried out. It is thought that a vaccine containing the predominant varieties of pasturella bacteria will help reduce losses due to shipping fever. It is of interest to note that the methods developed at ADRI for the classification of the pasturella bacteria are now being employed throughout the world.

* * *

"Tissue testing," writes Dr. Ward, on page 5, "is a simple and effective method for evaluating the nutritional status of a crop." He explains how good use has been made of tissue analysis in studies at Harrow. As an aid to practical agriculture, tissue analysis has numerous applications and could be much more widely used than it is at present.

* * *

Today, it is possible to analyze the oil from a single rape seed or even half a seed, says Dr. Downey, on page 6. It is fortunate, he states, that such a small amount of oil is sufficient since the fatty acid composition of the oil in rapeseed is controlled, not by the mother plant, but by the developing embryo in the seed. This means that each seed on a plant can differ in oil quality. At Saskatoon a technique was developed so that part of a rapeseed could be removed, and the oil extracted for analysis, without destroying the viability of the seed. This technique allows the plant breeder to select ungerminated seeds that will develop into plants with the desired oil quality. With greenhouses and growth rooms making three to four generations possible per year, Dr. Downey reports that in less than two years, several new types of rape oil have been identified and will be incorporated into new varieties. Nugget, developed at Saskatoon, is being distributed to farmers in 1962 for the first time.

Shipping fever causes loss of condition and weight.

"SHIPPING FEVER" Perennial Killer of Cattle

G. R. Carter

SHIPPING FEVER or stockyard's pneumonia is a perennial cause of losses in the cattle industry. It is seen in its most spectacular form in the feeders and stockers shipped to Ontario from Alberta and Saskatchewan during the late fall and early winter. Range cattle are rounded up, taken to sales in Western Canada and shipped to the East and various points in the West by rail or truck.

Shipping fever, or more accurately broncho-pneumonia, may develop enroute and several dead animals may be found on arrival at the stockyards. It frequently develops in the animals in the stockyards although it may not manifest itself until they have been trucked to farms. Shipping fever may spread from the Western cattle to native cattle in which the losses may be even greater. Every effort should be made, therefore, to keep the Western cattle completely separated from the native stock on the same premises. The greatest economic loss results not from deaths but from loss of condition and weight.

It is now generally agreed that shipping fever is a complex infection resulting from a combination of stresses and the interchange of potential disease-producing viruses and bacteria during the close association of the animals. Research workers have been unable to find any one cause of the disease syndrome nor have they been able to produce it experimentally and transmit it readily in the manner that other well-known diseases can be produced experimentally and transmitted. It seems probable that under stress the animals may become susceptible to infection with organisms to which they are ordinarily resistant.

Apparently normal calves often have a low-grade viral or enzootic pneumonia but a great deal of work remains to be done to elucidate the identity and character of the primary agent or agents inciting this condition. Examinations of the lesions in the calves, which are generally confined to the anterior portions of the lungs, have frequently yielded bacteria of the Pasteurella genus. *Pasteurella multocida* and *Pasteurella haemolytica* have been found consistently in the lungs of cattle with shipping fever pneumonia. Although they may be "secondary invaders", the fact that sulphonamides and antibiotics that inhibit their growth frequently cure shipping fever, supports the contention that these bacteria play an important role in the disease.

At the Animal Diseases Research Institute a serological classification of the pasteurella strains recovered from cattle with shipping fever is being carried out. It is thought that a vaccine containing the predominant varieties of pasteurella bacteria will

The author is a research officer with the Animal Pathology Laboratories, Health of Animals Division, Animal Diseases Research Institute, Hull, Que.

help reduce losses due to shipping fever. Several vaccines prepared according to recommendations growing out of this investigation are already being employed.

The typing of the two species of pasteurella is done by a specially developed haemagglutination test which is remarkably specific. The special typing sera are prepared by inoculating rabbits with various strains of killed pasteurella organisms. For example, if a culture called A is inoculated repeatedly into rabbits, antibodies will be produced in their sera which will clump red cells treated with an extract of culture A.

Several hundred strains of pasteurella bacteria from cases of shipping fever pneumonia have been examined by this test. By far the most prevalent variety is *P. haemolytica* (type 1). *P. multocida* (type A) was recovered occasionally along with *P. haemolytica* (type 1) from cases of shipping fever and also by itself from cases of bovine pneumonia not necessarily associated with shipping. It is recommended that bacterins for shipping fever contain both of these important types.

It is of interest that the methods developed at the Animal Diseases Research Institute for the classification of the pasteurella bacteria are now being employed throughout the world. A typing service is provided for foreign laboratories that for one reason or another are not able to carry out the tests. Scores of type cultures have been sent to veterinary laboratories in various parts of the world.

Future research on this important disease points up the need for special isolation facilities and the provision of so-called specific pathogen-free or disease-free cattle for experimental purposes. Because of previous exposure to viral agents and bacteria ordinary cattle do not make satisfactory experimental subjects.

Besides the agent or agents causing enzootic pneumonia of calves, other viruses may be involved in the bronchopneumonia of shipping fever. Three viruses that have been recovered in recent years from the respiratory tracts of cattle are being studied in the Animal Pathology Laboratories. These are the rhinotracheitis virus, the parainfluenza virus, and the psittacosis group of viruses. It remains to be shown what role, if any, these agents have in the causation of shipping fever.

Because the causes of shipping fever are complex it is not claimed that a pasteurella bacterin will prevent shipping fever. The varied and particular circumstances surrounding the development of the disease and the complexity of the infection, suggest that the discovery of a 100 per cent preventative is very unlikely. It is known, however, that pasteurella bacterins properly prepared will strengthen the animals resistance to invasion by these potential disease producers.

Shipping fever frequently develops in animals in the stockyards; may not manifest itself until animals have been trucked to farms.

Author taking specimen from tomato plant, preparatory to making tissue test.

TISSUE ANALYSIS

An Aid To Agriculture That Has Numerous Applications And Could Be Used More Widely

G. M. Ward

TISSUE TESTING is a simple and effective method for evaluating the nutritional status of a crop. It is a method that has been widely used by Department scientists in research and in co-operative experiments with growers.

A careful farmer should always be concerned about the proper nourishment of his crop plants. A fertile soil possesses sufficient quantities and a proper balance of all the nutrient elements necessary for the normal growth of crop plants. The practice of cropping will, however, eventually deplete any soil of its nutrient resources, particularly the major nutrient elements. These have to be replaced in the form of fertilizers if the soil is to remain fertile and productive. If they are not replaced and if the soil is lacking in any element or remains in an unbalanced state, this condition will soon be reflected in nutritional disorders in subsequent crops.

In tissue testing, a sample of plant material, usually leaf tissue, is analysed chemically to determine how much of each element is present. Research here, and elsewhere, involving tissue testing has established the optimum concentration ranges for nutrient elements in many crop plants.

In our studies at Harrow we have made good use of the two ways in which tissue analysis is helpful: (1) by helping to prevent nutritional trouble and (2) by providing a basis for diagnosis of nutritional trouble when it occurs. Visible symptoms of a nutritional deficiency or excess usually indicate that the disorder is well advanced and that immediate treatment is necessary to restore the plant to normal balance. It is better to avoid the trouble before it reaches this stage and this is possible only by tissue analysis. Trained agriculturists readily recognize many of the common deficiency symptoms but sometimes visible symptoms can be obscure or misleading. It is usually possible to clear up these difficulties with the aid of tissue analysis.

Tissue analysis has been widely used as an aid to proper nutrition of fruit trees, particularly apple. Regular annual analyses of foliar tissue furnish guidance for particular programs of fertilization. Incipient deficiencies have been detected and treated before they reached serious proportions. While this type of program is possible with perennial plants, it is not usually applicable to annual crops although the needs of a subsequent crop can sometimes be predicted from the nutritional response of the previous one.

When annual crops are to be fertilized while they are growing, their exact needs can usually be more accurately assessed if a tissue analysis is made. At Harrow, we have an experimental testing program in connection with greenhouse-grown tomatoes and cucumbers which are fed continuously throughout their entire growth period of six months or more. In this instance, controlled feeding can be more intelligently managed if regular tissue analysis is carried out to show the nutritional status of the plant.

Tissue analysis as an aid to practical agriculture has numerous applications and could be much more widely used than it is at present.

Dr. Ward is a specialist in plant nutrition and physiology, CDA Research Station, Harrow, Ont.

Rapeseed plant grown from half a seed.

Breeding for Quality in Rapeseed Oil

Selection of plants containing more desirable oils and their incorporation into adapted varieties is being accelerated at Saskatoon.

R. K. Downey

CANADA now reaps a harvest of 10 million dollars a year from the few pounds of rapeseed introduced to the prairies in 1942. Plant breeding at the Canada Agriculture Research Station, Saskatoon, has helped to bring about this harvest. New varieties that give higher oil yields or oil of more desirable quality have been developed through selection by conventional plant breeding methods.

Acceptability of a vegetable oil for any specific purpose is determined by its content of certain fatty acids. Oils high in linolenic acid, linoleic acid or erucic acid are valued for industrial purposes. Edible oils that are low in linolenic and palmitic acids command a premium.

Rapeseed oil is normally high in erucic acid, a characteristic that commends it for industrial use. But when used as an edible oil, a smaller content of erucic acid is preferred. Thus it appears that the most desirable rearrangement of fatty acids in rape oil for the present market is to reduce linolenic and erucic acids in edible oils to zero, increase the erucic acid in industrial oils, and at the same time maintain palmitic acid at the present low level.

Prior to 1959, intensive breeding for oil quality was not feasible since it took 3 days and a pound of oil to obtain a complete analysis of one sample. In 1958-1959, chemists adapted an instrument called the gas-liquid chromatograph (see photo) which gave the same results in three-quarters of an hour and required only a few drops of oil. The machine draws a picture of the fatty acid composition (see graph). Each peak on the chart represents an acid present in the oil, while the area under each peak gives the relative amount of that acid. Close co-operation between our plant breeders and the chemists at the Prairie Regional Laboratory of the National Research Council has

Under author's direction, technician (left) is preparing to inject oil from half a rape seed into the gas chromatograph. Fatty acids present in the previous sample have been drawn by recorder on right.

The author is oilseed crops specialist at the CDA Research Station, Saskatoon, Sask.

TABLE 1—PER CENT FATTY ACID COMPOSITION OF CANADIAN RAPE AND OTHER VEGETABLE OILS

	Palmitic	Stearic	Oleic	Linoleic	Linolenic	Eicosenoic	Erucic
Rape, *B. napus* Argentine type	4.0	1.5	17.0	13.0	9.0	14.5	41.0
Rape, *B. campestris* Polish type	2.9	1.1	33.6	17.9	9.4	11.5	23.5
Soybean*	11.5	3.9	24.6	52.0	8.0	0	0
Linseed*	6.1	3.8	15.5	15.3	59.3	0	0
Olive*	13.4	1.2	3.1	76.2	5.5	0.6	0
Peanut*	10.1	3.2	53.9	24.2	0	3.3	3.2**
Corn*	12.1	2.3	28.7	56.2	0.7	0	0
Sunflower*	7.2	4.1	16.2	72.5	0	0	0
Safflower	7.2	2.1	9.7	81.0	0	0	0

* Determined by gas-liquid chromatography (See Craig, B. M., and N. L. Murty. J. Am. Oil Chemists' Soc. 36 : 549-552. 1959).
** Present as Behenic acid, 2.1% Lignoceric acid is also present.

enabled refinements to be made in these earlier techniques.

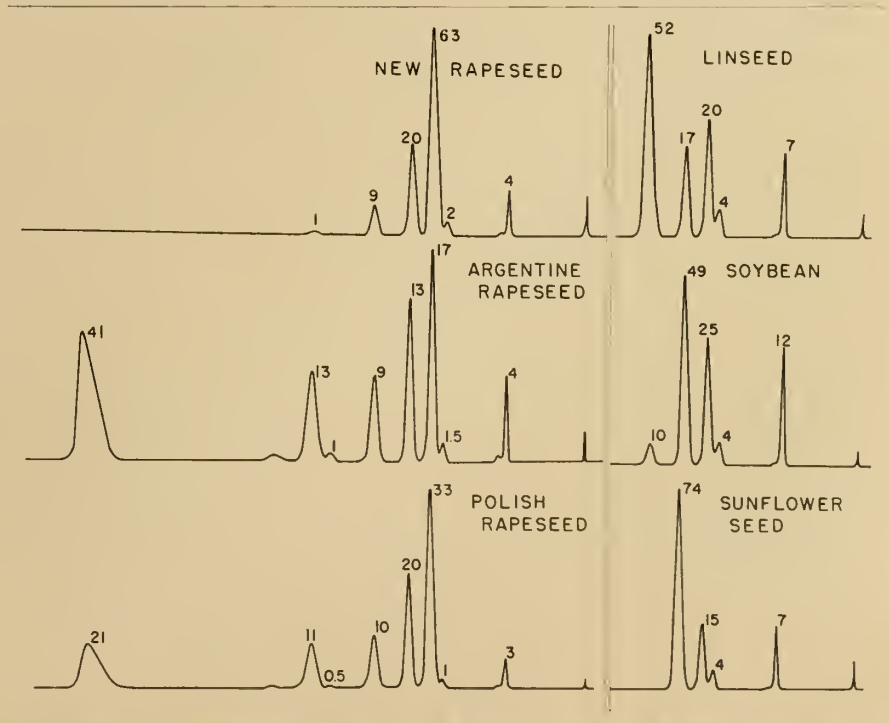
Today we can analyse the oil from a single rape seed or even half a seed. It is fortunate that such a small amount of oil is sufficient since the fatty acid composition of the oil in rapeseed is controlled, not by the mother plant, but by the developing embryo in the seed. This means that each seed on a plant can differ in oil quality. At Saskatoon a technique was developed so that part of a rapeseed could be removed, and the oil extracted for analysis, without destroying the viability of the seed. This technique allows the breeder to select ungerminated seeds that will develop into plants with the desired oil quality.

The development of these methods and techniques has permitted an intensive survey of the fatty acid variation present in the two species of rape, *Brassica napus* and *B. campestris*, as well as oils from their close relatives, mustard, cabbage, and turnip. The search was more rewarding than expected. Some of the extremes found in the two species of rape are given in Table 2. Selection within a German variety of *B. napus* isolated plants containing no erucic acid. This characteristic is now being combined with the high oil and seed yields of adapted varieties. The other extreme in erucic acid content was found in a yellow seeded variety from India, the seeds of which contain over 50% erucic acid, or 10% more than the high previously found. The search for a rape oil with low linolenic acid, among foreign varieties and related species, was not successful. However, one of our own varieties, Nugget, was found to contain one-third less linolenic acid than ordinary rapeseed. Not only does this variety contain less linolenic acid but it also is 1.5 to 2% higher in oil content than varieties previously available. Seed of Nugget is being distributed to farmers in 1962 for the first time.

TABLE 2—PER CENT FATTY ACID COMPOSITION OF SELECTIONS FOR IMPROVED OIL QUALITY IN COMPARISON WITH PRESENT VARIETIES GOLDEN, POLISH, AND ARLO

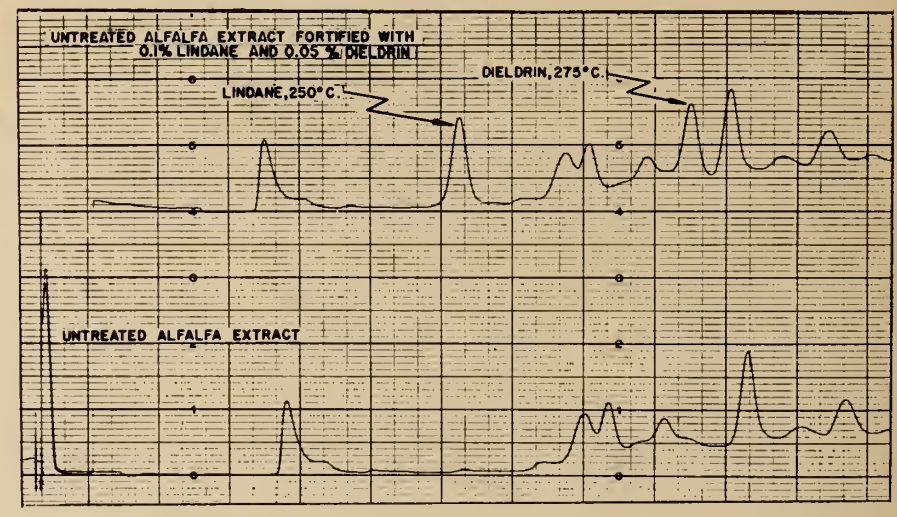
	Palmitic	Stearic	Oleic	Linoleic	Linolenic	Eicosenoic	Erucic
B. napus							
Golden	3.3	1.1	18.6	14.0	7.8	13.4	41.8
Zero erucic selection	4.7	1.8	63.3	20.0	8.9	1.3	0
Nugget, low linolenic	3.3	1.5	22.5	12.2	5.4	14.2	40.6
B. campestris							
Polish	2.9	1.1	33.6	17.9	9.4	11.5	23.5
Arlo	3.0	1.1	26.6	17.5	8.8	11.8	31.0
Indian selection	2.1	0.8	10.4	12.4	10.4	8.7	55.2

Selection of plants containing these more desirable oils and their incorporation into adapted varieties is being accelerated at Saskatoon. The potential oil quality of plants can be identified in the seed before it germinates, and this saves one generation in growing time. The use of greenhouse and growth rooms further speeds production by allowing the growth of three to four generations a year. Thus, in less than two years, several new types of rape oil have been identified and will be incorporated into new varieties. This progress will make it possible for producers to meet the increasingly varied demands of both the domestic and foreign oil markets. The search for other useful types of oil is continuing.



Gas-liquid chromatographic analysis of linseed, soybean, sunflower oils, and Polish and Argentine, and the new zero erucic acid rapeseed oils. Peaks for fatty acids, reading from right to left on each graph, are: palmitic, stearic, oleic, linoleic, linolenic, arachidic, eicosenoic, and erucic. The amounts of each acid are given above the peak for the acid in the graph.

Left: Author examines the automatically recorded interference "peaks" on a temperature-programmed gas chromatograph used in pesticide research. *Below:* Two recordings from the gas chromatograph, showing, in lower curve, interfering substances normally present in untreated alfalfa extract. Upper curve is identical with lower, except for 0.04 ml. of hexane solution of lindane and dieldrin added to untreated alfalfa extract.



Pesticide Residue Research Discoveries

Ben Berck

THE distribution and persistence of pesticide residues are studied at the pesticide residue analysis laboratory at the Canada Department of Agriculture Research Station at Winnipeg. In addition to investigating practical problems in which pesticides are involved, we are also exploring fundamental aspects of the use of certain agricultural chemicals.

A direct result of our investigations of residues is a better understanding of factors that influence the effectiveness of pesticides under Western Canadian conditions, and how to get the *most effective control with the least amount of chemical treatment.*

The following examples indicate some of the useful results we have obtained. Some of the projects were undertaken in collaboration with other government and industrial laboratories.

Discovery About DDT:—By chemical analysis we showed that DDT "effloresced" from wood surfaces, that is, the DDT was rapidly absorbed within the wood cells and, later, slowly migrated outwards to crystallize on the wood surface. The nature of the formulation and the solvent were influencing factors. Thus, time must accordingly be taken into account in assessing the maximum effectiveness of a given treatment. In another investigation, DDT applied to the bark of elm trees in the Winnipeg area, and subject to temperatures that ranged from —38° to +100° F., persisted in the surface layer for at least 14 years.

Break-through on Biting Fly Control:—We established that suspended solids in river water can adsorb DDT and being surface-active, can transport DDT for long distances (up to 118 miles from point of application). This advanced a new concept for the measurement of long-range action of DDT when applied as a black fly larvicide, and spotlighted the previously unsuspected role of suspended solids as DDT carriers. This behaviour of suspended solids was confirmed in another project pertaining to chemical control of mosquito-breeding areas. During the course of this work, a method was developed for measuring DDT and similar pesticides in water in amounts as low as 1 part in 10 billion.

Improving Grain Fumigation Methods:—We showed that a grain pile could behave as if it were a "chromatographic column" towards fumigants applied to the top of a grain bin. Each fumigant tested had a different affinity for wheat in experimental columns, and the retention (or "sorption") varied with the temperature and moisture content of the wheat. Interestingly, when carbon tetrachloride was present in combination with methyl bromide, ethylene dibromide, acrylonitrile or chloropicrin, it acted as a carrier

Residue Studies of DDT, Dieldrin, Toxaphene, Fumigants and Other Chemicals Yield Important Facts for Farmers

Mr. Berck is a chemist specializing in the analysis of pesticide residues at the CDA Research Station, Winnipeg, Man.

gas, and assisted the downward penetration of the other and more toxic gases. In reconnaissance tests, a dockage content of 2% weed seeds was shown to hold back significant amounts of gas. Tests are planned for the evaluation of new carrier gases. Such research is of practical importance, particularly for grain elevators and farms in Western Canada, where temperatures are comparatively low, and optimum gas diffusion is thus retarded. A side result of such research is the development of improved methods of gas sampling and of four new methods of microdetermination of fumigant gases. Work is presently under way to determine the amount of fumigant gas that is retained by glass, plastic, metal and wood surfaces.

Reducing DDT Residue on Celery:—When DDT was applied as a dust treatment to celery, residues increased peripherally from the heart. Residues were heaviest at the lower or butt ends of the leaf stalk. Removal of the outermost leaves at harvest produced a large reduction in total DDT residue. Commercial washing reduced the remaining residue by 40–60%. The highest residual deposit left on the celery plants after washing was 4.5 ppm. In another project we showed that DDT applied in high concentration to onions could be translocated from outside the bulb to the onion greens.

New Method of Measuring Mercury in Fungicide-Treated Wheat:—We recently developed a new and rapid method of measuring mercury in fungicide-treated wheat in samples as small as one kernel, and established that mercury could be transferred in the vapor phase from treated to untreated seed. Work is presently underway to explore more fully the distribution and persistence of mercury in cereal seeds. A side result of this collaborative research is the development of a simple method of crushing small grain samples for analysis, and improved methods of micro measurement of fungicidal and insecticidal compounds of other metals such as copper, zinc, nickel, arsenic and thallium.

Residue Levels on Alfalfa Studied:—We are presently analysing alfalfa for residual amounts of dieldrin and toxaphene that were applied as grasshopper poisons in a field experiment. The objective is to determine the rate of degradation or loss of these pesticides as a result of weathering, evaporation, etc., as well as growth dilution. Research on removal of interfering compounds naturally present in alfalfa has paid off, and we hope to have results shortly on the residue levels.

This attempt to compress general and specific research problems pertaining to pesticide research, along with background information, into a compact article is necessarily limited and incomplete. We hope that the reader has nevertheless gained a better idea of the nature of our work.

Technician operates a polarograph with a dropping mercury electrode to measure fumigant concentration.

Above: National Mycological Herbarium at Ottawa.

Left: A common lawn mushroom, *Marasmius oreades* (Bolt. ex Fr.) Fr. Mag. x 2/3.

The National Collection of Fungi

J. A. Parmelee

FUNGI abound in nature—they may aid or hinder our efforts to grow and store crops. To recognize and understand these important organisms, we must have ample specimens for comparison. For this purpose the Canada Department of Agriculture maintains the National Mycological Herbarium at Ottawa.

It is generally accepted that fungi are plants if we agree that all living organisms are plants or animals. Most people recognize the mushroom (or toadstool) as one form of fungus, and many know the variously sized conks or brackets on standing or fallen trees as yet another form. Farmers and city folk are coming to know that the blackening smuts of corn and grain, rusts of cereals and grasses belong to this same world of the fungi. Grocers, familiar with the losses caused by blue and green moulds of fruits and vegetables in storage, know little of the lives and loves going on unnoticed in the refuse pail. Such pails scattered around the world may be the source of origin of a fungus from which future stocks of an antibiotic are drawn. Few indeed know of the role played by fungi in reducing dead trees, shrubs and herbaceous plants of forest and meadow into the organic compounds necessary for the nutrition and regeneration of plant growth. Fungi are not alone in this important work for insects and other animals and bacteria also help to break down plant remains into plant food.

In the Mycology Section we are concerned primarily with basic research in the fungi. This includes naming, classification, and studies in development, structure, nutrition and host plant relationship. Other important endeavours are concerned with sexual studies which bring to light the manner in which the fructification (e.g. the mushroom) forms. The linking of asexual stages to sexual stages is still another important field of study. Currently, the biochemistry of these organisms is being studied to further their identification where this is not practicable through morphological studies alone.

Perhaps the question comes to mind: Why should we concern ourselves with the names of fungi? The scientific name of a fungus can be thought of as the combination which unlocks the storehouse of information already known, and recorded, about a particular

The author is a mycologist with the Plant Research Institute, Ottawa, Ont.

species. Thus the basis for solving any problem—be it control of plant or animal parasite, remedy for mushroom poisoning, prevention of wood decay or the search for and production of antibiotics —is the correct identification of the fungus involved.

The herbarium and the mycological library are basic tools that serve this particular discipline. The history or what is already known about a particular fungus can be found in the library, and in the herbarium, specimens are available for direct comparison with an "unknown". The information obtained from both sources is complementary in providing as complete a picture as possible of the structure, the general and local distribution, the hosts or substrates involved, and the time of year and the conditions under which a particular fungus may appear. The microscope enables an investigator to observe morphological features not visible to the unaided eye.

What happens to fungus specimens received at the National Mycological Herbarium? Once we identify and consider them worth retaining, they are dried by gentle heat and often with slight to considerable pressure depending on the kind of fungi. They are packeted in paper envelopes or bulky specimens are stored in boxes, and labelled with as complete data as available. They are then housed in steel cabinets according to alphabetical sequence within the accumulated material of related fungus groups. This filing method, in conjunction with a host indexing system and a numerical accessioning system, permits specific fungi and related kinds to be located quickly and efficiently for reference. To protect the collection against the ravages of insects, fumigants are kept replenished in the herbarium cases. If free of insects, well-preserved specimens will keep for hundreds of years.

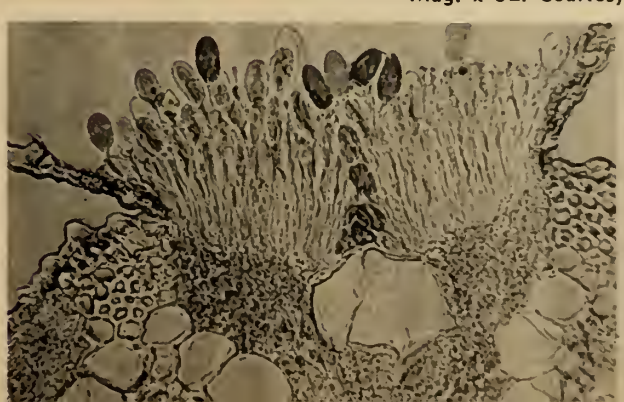
Wood decay fungus on fallen log, *Hericium* sp. Mag. x ca 1/10.

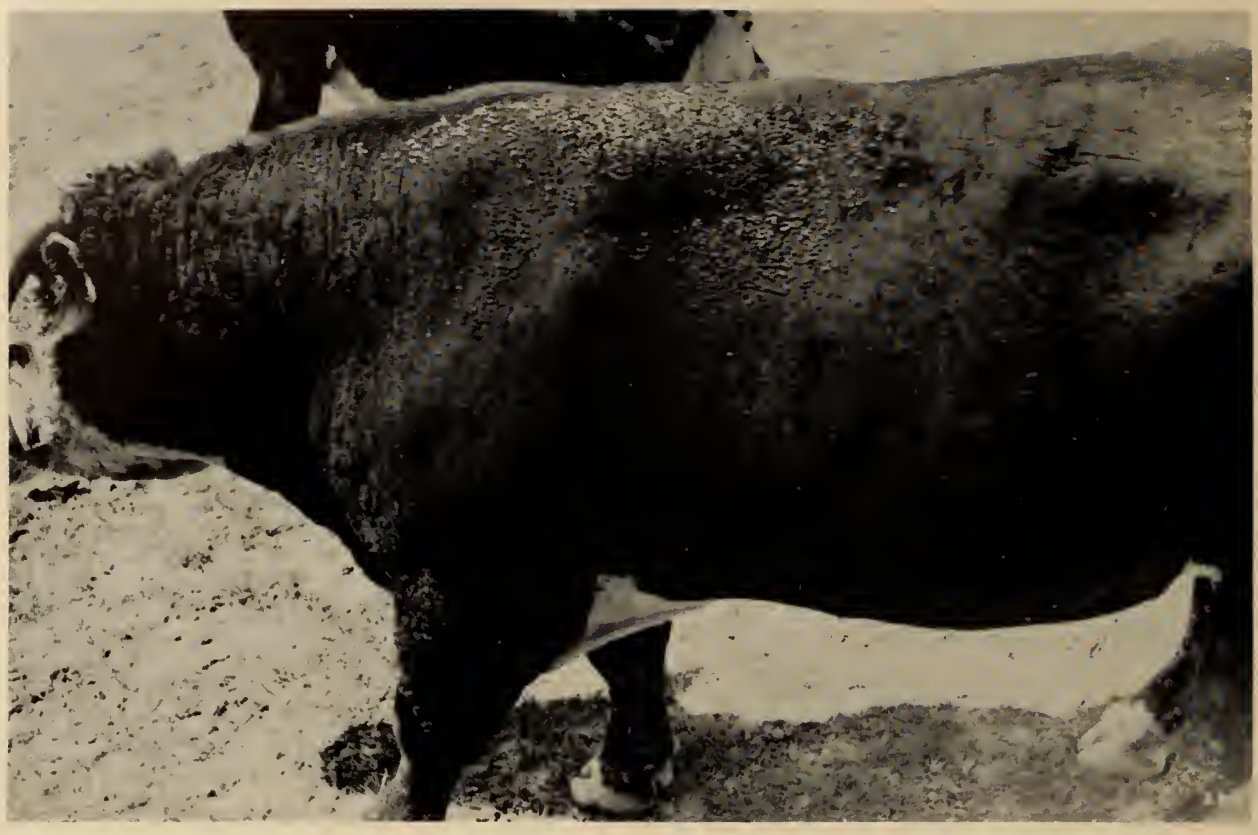
The herbarium presently houses over 100,000 specimens and this number increases by a conservative estimate of 5,000 annually. As already noted, specimens originate largely from the field activity of the staff. In addition, contributions of specimens are regularly received from Regional Research Laboratories and Forest Pathology Laboratories across Canada some of which may maintain their own herbaria. It should be noted here that much important work with parasitic fungi of economically important hosts like cereals, fruits, vegetables, forages and forest trees is being conducted at these laboratories. The purchase of prepared specimens is sometimes possible and additional specimens may be obtained when an individual or institution discontinues activity in this field.

An exchange program is maintained with a growing number of herbaria (currently 26) located in Canada, United States, Europe, India, New Zealand, China and Japan. From these sources, a nucleus of European and Asian material is available for comparison with Canadian material, which rightly comprises the bulk of specimens in the herbarium at Ottawa. In the last decade, due to increasing development in the North, it has been possible to visit and collect representative fungi in Canada's low and high arctic regions thus enlarging our knowledge of the kinds and dispersal of fungi throughout this formerly inaccessible area.

The identification of economically important fungi can be most expediently handled by the nearest Regional Agricultural Laboratory. However, extension agriculturists should be aware of the national repository for fungi located at Ottawa. Any inquiries in this vein should be addressed to The Curator, National Mycological Herbarium, Plant Research Institute, Central Experimental Farm, Ottawa, Ont.

***Left:* Cross section of rust parasitizing grass leaf, *Puccinia phragmitis* (Schum.) Koern. on *Phragmites communis* L. Mag. x 200. *Right:* A leaf litter fungus on needles of fir, *Thysanophora penicilloides* (Roum.) Kendrick on *Abies*. Mag. x 32. Courtesy Dr. W. B. Kendrick.**





Horn flies on a bull; bites and attacks produce avoidance reaction which may affect rate of gain in beef cattle.

Horn Fly Problem in Western Canada

K. R. Depner

THE horn fly, a small, dark, blood-sucking insect, poses a problem for Canadian cattlemen each summer. Its bites irritate cattle and its attacks affect the animal's grazing habits. The cattle, vainly attempting to rid themselves of the pest, seek any shelter and often spend a large part of the day in it when ordinarily they would be grazing. Horn flies on the animal increase its nervousness and irritability, causing it to kick at its belly, lash its tail and swing its head from side to side.

Experiments at the Canada Agriculture Research Station at Lethbridge, Alta., have shown that as few as eight horn flies per animal may produce an avoidance reaction in pasturing cattle. This reaction, with its consequent effect on feeding habits, nervousness and increased movement may have a significant effect on the rate of gain in beef cattle and on milk production in dairy animals.

The author is a livestock insect specialist at the CDA Research Station, Lethbridge, Alta.

The horn fly is not native to this country and was introduced to North America from Europe in the latter part of the 19th century. Within a very few years it had spread from New Jersey in the United States, completely across the country and into Canada, both in the east and in the southern part of Western Canada. While the 3,000 mile westward spread was accomplished in about ten years, a northward spread of only 300 miles required about four decades. Horn flies were unknown in the Edmonton area previous to the early 1950's.

A considerable amount of work on the effect of horn flies on dairy animals has been done in the United States. There is reasonably good evidence now that under pasture conditions these flies cause a considerable reduction in milk yield.

Work at Lethbridge indicates that this effect does not occur to the same extent when cattle are kept in a small enclosure. In a small pen, the avoidance reaction is highly restricted, and the cattle rapidly adapt to the presence of horn flies, even though several hundred flies are maintained on each animal. This applies, of course, only if adequate feed and water are provided.

The abundance of horn flies varies with the region. The greatest numbers per animal are found on the Canadian prairies. These numbers generally decrease in wooded areas. In our investigations, we have found that the

number of flies varies in Alberta from several thousand per animal in the Lethbridge area, to 50 or less in the foothills. The decrease is related to both increasing latitude and altitude. We discovered in the Edmonton area that cattle generally have about one-tenth as many horn flies per animal as in the Lethbridge area. North of Edmonton, the numbers of flies dwindle until they disappear at the northern limits of distribution. In Alberta, this limit is now at the latitude of Grande Prairie, and in British Columbia it is a few miles north of Prince George.

Nature Limits Horn Flies

Many factors in nature combine to limit the population of horn flies each season. Cold rainy weather will reduce the number of adults on cattle. The immature stages are vulnerable in cattle droppings, to attack by birds, rodents and predacious insects. One of the important factors helping to control this pest, particularly in the foothills of southwestern Alberta, is parasitism by other insects. Our work at Lethbridge has revealed the presence of four separate *Hymenopterous* parasites of horn flies. Of these, one has been identified and named, and three others are previously unknown species. The female of each of these parasites drills a small hole in the puparium of a horn fly and lays an egg on the developing insect. When these eggs hatch, the grubs feed on the young horn fly, consume the greater part of it and eventually pupate within the puparium of the host. When it is ready to emerge, the new adult of the parasite chews a hole through the horn fly puparium and escapes. The percentage of parasitism in horn flies varies with the area. On the prairie at Lethbridge the incidence is very low, but is much higher in the foothills and wooded areas of the western part of the province.

To sum up, evidence indicates that horn flies in Alberta are a greater problem on the prairies of the south than in the foothills of the west and the wooded areas of the north. The effects of horn flies on the comfort and productivity of cattle appear to be of less consequence when animals are kept in feedlots or other small pens.

HORN FLY HOST

The horn fly is an obligate parasite of cattle and cannot complete its life cycle without this host. The eggs are laid under freshly passed cattle droppings where the immature stages develop. The adults remain on cattle continuously except for short flights by the females to lay eggs. In Alberta, the native bison can serve as an alternate host but none of the deer, sheep or antelope native to the country are satisfactory hosts for the flies. Normally, horn flies do not attack humans but may sometimes be seen sitting on barnyard animals other than cattle. The droppings of these animals are not suitable as breeding sites and therefore play no part in propagating the pest.

Horn flies on a cow produce avoidance reaction in pasturing cattle and may affect milk production of dairy animals.

Two different views of hedge garden at Morden Experimental Farm.

Hedges for Prairie Farmers

H.F. Harp

New varieties of hedge plants and improved methods of maintenance have substantially increased the value and use of hedges on the prairie farm. At the present time there are 85 different kinds of hedges on test at the Experimental Farm, Morden, Man. Many of these are especially well suited for the farmstead and are more colorful and superior to Siberian caragana, Common lilac, and Tatarian honeysuckle which formerly were used exclusively.

On the farm, hedges have a particular appeal. They give protection from the wind, screen unsightly buildings, give relief from the boundless expanse on prairie farms, lend beauty to the modern architectural design of homes, and provide a background for the flower border. However, a more rigorous prerequisite for hedging material is that it must survive on the Canadian Prairies, and stand up to the pruning necessary to keep the hedges in shape.

Morden Test

Species of trees and shrubs have been evaluated for their use as hedges in a test plot at Morden for thirty years. In 1931, 78 species were planted. Since then, 130 species and varieties have been grown, some continuously and others replacing hedges no longer useful or worthwhile. Plants tested as hedging material were rated for hardiness, vigour, and for special uses. Our recommendations are summarized in the accompanying table. The hedge test area is surrounded by tall evergreen and deciduous trees which give good protection from wind, trap snow in the area, and in the summertime provide an attractive setting for what has become a special feature of the ornamental projects carried at Morden. Most of the test hedges are 50 feet long, each separated by a strip of grass six feet wide. There are four hedges in each row and between each row there is a grass walk ten feet wide. In some instances the length allotted to one species has been equally divided between the two dwarf varieties, thereby increasing the number of varieties on test.

Pruning

Once hedges were established it was necessary to determine how the plants would survive pruning and shaping. Newly planted deciduous hedges, where one or two-year old stock had been used, were cut back to within six to nine inches of ground level to ensure the development of basal shoots that would lay the foundation of a dense hedge. If older stock had been used, we pruned less severely, removing not more than one-third of the total height of the plant. The aim was to develop as quickly as possible a thick, bushy hedge, well furnished with low twiggy growths. The ultimate shape that best combines beauty with utility is sometimes called the 'inverted vee' or 'narrow pyramidal'. Good proportions for a hedge, we found, are two and a half feet wide at ground level, five feet tall with the top rounded and not more than one foot wide. Some hedges were kept neat and tidy when trimmed only once a year. Other hedges with more vigorous growth needed at least three trimmings.

Pruning requirements of evergreen hedges differed considerably from deciduous ones. No pruning was necessary at planting time nor for two years, except to prune back the 'leaders'. Conifers will not recover from hard pruning as will the deciduous hedges, we found, and should not be pruned beyond the current year's growth.

The author is with the Experimental Farm, Morden, Man.

Deciduous hedges in the test at Morden which became unthrifty and unsightly with age were rejuvenated by hard pruning. The main trunk and heavy branches were cut back in October, using tree pruners or a pruning saw. The smaller side branches and basal shoots were left intact until the following April when they were pruned back fairly close to the main trunk.

The main center shoots were then about two feet in height and the skeleton outline of the newly rejuvenated hedge had the same proportion of width to height as had the mature hedge. No further pruning was necessary until the following year except to reduce the most vigorous shoots to half their length in July. Thereafter the pruning pattern followed that outlined for deciduous hedges.

Willows grown as informal hedges for winter color can be cut down every year. This hard pruning or coppicing is best done in April before the buds open. The current season's growth of new wood will then provide a hedge of attractive color the next winter.

Hardy Trees and Shrubs Which Have Proved Suitable for a Hedge under Special Conditions or for Purposes as Described

Alkaline soil—Saltbush, Buffaloberry, Russian olive.
Shade—Cedar, Alpine currant, Japanese barberry.
Flowering hedges—Common lilac, Threelobe spirea, Altai rose.
Autumn color—Ginnala maple, Winged euonymus, Siberian larch.
Winter color—Golden willow, Siberian dogwood, Redstem willow.

Fast growing—Dropmore elm, Siberian caragana, Willows.
Slow growing—Bur oak, Swiss stone pine, Spruce.

Tall—Green ash, Hawthorns, Villosa lilac.
Medium—Cottoneaster, Winged euonymus, Sweetberry honeysuckle.
Dwarf—Alpine currant, Pygmy caragana, Farrer's cinquefoil.

Diseases and Pests

Hedge plants like all others are subject to attacks of insect pests and diseases. Diseases were never serious problems in our hedge test area, but some species of plants are susceptible to leaf spot, mildew, and fireblight. Modern fungicides will control the first two. There is no remedy for fireblight, but it is important to cut out diseased parts of the plants and burn them. Leaf-eating caterpillars, spider mites, aphids, and scale insects are the most serious insect pests. Insecticides such as DDT, malathion, or aramite have given effective control. Scurfy scale and pine needle scale are two insects whose damage may not be apparent until the weakened plants are killed by winter injury. Effective control measures are only possible at the critical period of the insect's life cycle, when it emerges from beneath its impervious scale. In normal seasons at Morden, this occurs around May 15th for scurfy scale and June 1st for pine needle scale.

1. Method of rejuvenating a hedge, which has become too tall, by hand pruning. Photo shows growth recovery, after 2 years, of American elm. 2. American elm hedge 2 years after it was reduced from 15 feet to 2 feet in height. 3. Method of 'laying' a Siberian crabapple hedge to fill in spaces. 4. Gaps which have been filled in by laying Siberian crabapple. 5. Willows are coppiced annually. 6. Common lilac hedge cut back.

26 species of wireworm have been found in B.C. farm land.

British Columbia . . .

Wireworm Problems

A. T. S. Wilkinson

Author dissecting wireworm. *Inset:* Internal structure of hind gut (x 125).

IN investigations conducted by the Vancouver Research Station on wireworms in grain, potato, and vegetable crops, we have collected 26 species from cultivated land and identified them. Six are widespread pests and twelve on occasion caused damage. The remaining eight are not known to damage crops.

The term wireworm, of course, does not describe a single species but is the common name given to the larval stage of all species in the beetle family Elateridae. In British Columbia there are over 150 species in this family. Fortunately not all wireworms are agricultural pests. Most of them live in the forests and little or nothing is known of their habits.

Most of the agricultural areas in British Columbia have been surveyed for wireworms to determine the species present and their importance as pests.

The most widespread is the Puget Sound wireworm, which is found in all agricultural land of the province including the Peace River area. It prefers well-drained soils and has been found with three other species damaging wheat wherever it is grown in B.C. A very close relative and one of the most important wireworm pests of Canada, the prairie grain wireworm, is found only in the Peace River area.

Much more localized in distribution are two species, with no common names, which we found in the lower Fraser Valley. They are particularly damaging to potatoes grown in the delta of the Fraser River. We discovered mixed populations in silty loam, but found only one in peat soil. Our studies revealed that both species build up when sod is undisturbed for several years and the damage is done when potatoes are later grown on this land. Greater losses are incurred in the second than in the first year of potatoes following sod. It is thought that in the first year the wireworms prefer to feed on the decomposing sod and volunteer grass. By the second year, most of the grass has been killed and the wireworms are forced to feed on the potatoes.

Even more localized in distribution in this area is a third wireworm which we found mostly in poorly drained fields. Much smaller than the other two wireworms, it causes some damage by feeding on potato seed pieces.

Two species, the Pacific Coast wireworm and the western field wireworm, are found together in light, moist, soil throughout southern British Columbia causing damage to vegetables. Both species are well adapted to conditions in irrigated fields of the Okanagan, Boundary and Kootenay areas. Because of their ability to increase under cultivation, they are probably the most destructive wireworms in the province.

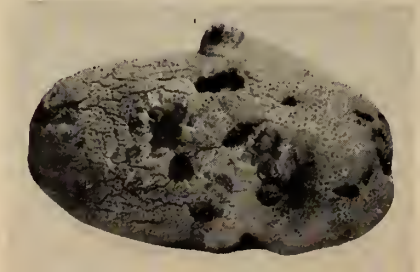
In addition to these native species, two of the worst wireworm pests of Europe were accidentally introduced into this province about the turn of the century. Both species are apparently confined to two small areas. Both are present near Cobble Hill on Vancouver Island, and one species near Agassiz in the lower Fraser Valley. Our investigations revealed that populations have reached 20 wireworms per square foot, indicating that conditions are suitable. Fortunately, they spread slowly.

During the past four years, we have studied life histories of several species from the lower Fraser Valley. We found that the different species vary considerably in the time needed to complete their life cycle. Of three species reared under similar conditions, one species had a life cycle of two years, a second of three years, and a third species is still in the larval stage after four years.

We have conducted experiments on control of wireworms in several locations in various soils. The best results were obtained with aldrin or heptachlor at 5 lb. of toxicant per acre worked into the top six inches of soil before planting. Single applications of either of these materials protected the crop in the first season and gave a complete kill of wireworms in the second. No reinfestation had occurred by the ninth season.

Each year losses from wireworm damage in British Columbia are becoming less and enquiries on control fewer. This is thought to result from the extensive use of soil treatments not only for control of wireworms but also for other soil insects such as cutworms, white grubs, the tuber flea beetle, root weevils, and root maggots. The combination of the long life cycle of the wireworms and the persistence of aldrin or heptachlor in the soil has reduced wireworms from a major to a minor pest.

Wireworm feeding tunnels in potato.



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