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DOMINION OF CANADA

FIFTEENTH ANNUAL REPORT

OF THE

NATIONAL RESEARCH COUNCIL

CONTAINING THE

REPORT OF THE PRESIDENT

AND

FINANCIAL STATEMENT



1931-1932

OTTAWA, CANADA

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1931-32

NATIONAL RESEARCH COUNCIL

OF THE

FIFTEENTH ANNUAL REPORT

AND

REPORT OF THE PRESIDENT

FOR THE

FINANCIAL STATEMENT

DOMINION OF CANADA

1931 - 1932

OTTAWA, CANADA

The Hon. H. H. Stevens,

Chairman, Committee of the Privy Council on Scientific and Industrial Research,

Ottawa, Ontario.

Sir:

I have the honor of presenting to you herewith the Fifteenth Annual Report of the National Research Council, for the fiscal year 1931-1932.

In accordance with the requirements of the Research Council Act, this report contains the report of the President and a statement of the receipts and expenditures of the Council during the year under review.

Your obedient servant,

H. M. TORY,

President, National Research Council.

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THE COMMITTEE OF THE PRIVY COUNCIL ON SCIENTIFIC AND INDUSTRIAL RESEARCH

MINISTER OF TRADE AND COMMERCE, *Chairman*
MINISTER OF FINANCE
MINISTER OF MINES
MINISTER OF AGRICULTURE
MINISTER OF PENSIONS AND NATIONAL HEALTH
MINISTER OF LABOR
MINISTER OF NATIONAL DEFENCE

NATIONAL RESEARCH COUNCIL
1931-1932

President:
H. M. TORY, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., Ottawa, Ont.

Secretary-Treasurer:
S. P. EAGLESON, ESQ., Ottawa, Ont.

Members:

FRANK ALLEN, M.A., Ph.D., LL.D., F.R.S.C., Head of the Department of Physics, University of Manitoba, Winnipeg, Man.

CHARLES L. BURTON, ESQ., President, Robert Simpson Company, Limited, Toronto, Ont.

CHARLES CAMSELL, B.Sc., LL.D., F.R.S.C., Deputy Minister, Department of Mines, Ottawa, Ont.

H. R. CHRISTIE, B.Sc.F., Head of the Department of Forestry, University of British Columbia, Vancouver, B.C.

A. L. CLARK, B.Sc., Ph.D., F.R.S.C., Hon. M.E.I.C., Dean, Faculty of Applied Science, Queen's University, Kingston, Ont.

J. T. FOSTER, ESQ., Vice-President, Trades and Labor Congress of Canada and President of the Montreal Trades and Labor Council, 747 Stuart Ave., Outremont, Que.

A. FRIGON, B.Sc., D.Sc., A.M.A.I.E.E., A.M.E.I.C., Dean, Ecole Polytechnique and General Director for Technical Education in the Province of Quebec, 1430 St. Denis Street, Montreal, Que.

SIR GEORGE GARNEAU, B.A.Sc., LL.D., 71 St. Peter Street, Quebec, Que.

J. H. GRISDALE, B.Agr., D.Sc.Agr., Deputy Minister, Department of Agriculture, Ottawa, Ont.

F. M. G. JOHNSON, M.Sc., Ph.D., F.I.C., F.R.S.C., Dean of Science and Director of the Department of Chemistry, McGill University, Montreal, Que.

O. KLOTZ, M.B., M.D., C.M.McG., F.R.C.P., Professor of Pathology and Bacteriology, University of Toronto, Toronto, Ont.

J. W. SHIPLEY, B.A., A.M., Ph.D., F.C.I.C., F.R.S.C., Professor of Chemistry, University of Alberta, Edmonton, Alta.

JULIAN C. SMITH, M.E., LL.D., M.E.I.C., Shawinigan Water and Power Company, Montreal, Que.

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FIFTEENTH ANNUAL REPORT

OF THE

NATIONAL RESEARCH COUNCIL

REVIEW OF THE ACTIVITIES OF THE NATIONAL RESEARCH COUNCIL

Introduction

The National Research Council, on March 31, 1932, completed the fifteenth year of its existence. At this time a distinct period in the life of the Council ends, and a new period, with greater opportunities because of new facilities for research, begins.

For nearly the whole of the period since its foundation, in 1916, the Council has been without laboratory facilities under its own control, excepting those of a very temporary character. The projected National Research Laboratories on Sussex Street, Ottawa, are now being completed and will be available for active occupation early in the new fiscal year. A complete description of these facilities will appear in the next annual report; suffice it to say, for the moment, that every effort has been made to plan a laboratory system of the most modern type, in which researches arising out of Canadian needs can be effectively carried on.

It is respectfully suggested that the work accomplished by the National Research Council to date, and the methods pursued in effecting it as outlined below, have justified the grants made by parliament both for current expenses and construction of national laboratories as well. The National Research Laboratories are a national investment, the returns from which must, for the most part, be in the future. These returns will come as the laboratories are adequately supported, equipped and staffed.

During the year the method followed by the Council in the administration of its funds has been in accord with the general policy followed since the Council received its new charter in the Research Council Act of 1924. It has directed its activities along the following lines during the year under review:—

(1) Promoting, through a system of scholarships, the training of personnel for research activities;

(2) By assisted research grants, promoting research in university and other laboratories;

(The effect of these two items of policy upon research in Canada has been of great significance, not only in promoting research activities in the universities generally but in stimulating graduate instruction in several of the larger institutions.)

(3) Through the operation of associate and research committees, effecting co-operation in investigations where the problems to be solved were of such a nature as to demand the help of personnel with a great variety of training and of different organizations and institutions;

(4) Carrying on such special investigations as were possible in the temporary laboratories occupied by the staff which had been selected as the nucleus of the staff of the National Research Laboratories. Included among these are investigations in which particular industries or a group of industries have co-operated in bearing a share of the cost;

(5) Through the Division of Research Information, keeping abreast of the developments of science in all countries by an examination of the technical and scientific literature as it appears from month to month, and preparing and issuing reports thereon for the scientific staff of the Council, for investigators in other laboratories receiving assistance from the Council, and for representatives of industry;

(6) The systematic development of standardization to meet the practical needs of industry and commerce. An aim of the National Research Council is to provide facilities that will make dependence on foreign laboratories unnecessary.

During the year substantial progress has been made in extending and consolidating the Council's efforts, as a review of the statements made in later sections of this report will show.

In our last report it was stated that during the year the demand for scientific assistance from industrial groups had greatly increased. This statement can be repeated with special emphasis with regard to the year just closed. In a recent month the number of technical enquiries alone totalled approximately one hundred. These were in addition to a number of requests for financial assistance and for investigations to be undertaken.

During the year the Council has been able to extend its connection directly with industry in a way that has not been possible heretofore. A number of associate committees, in the work of which representatives of the industries participated, have been called into being as a result of the Council's effort to relate itself intimately to industrial development. This association of the Council with industry has been made a definite part of the Council's policy because it feels confident that science will not occupy its proper place until the industrialist is ready, not merely to admit the possibilities of research and to accept its assistance, but to co-operate fully and on a confidential basis with the workers in the scientific field. The success of the scientific workers under the direction of the Council in assisting industry has been almost in proportion to the intimate relations that can be thus established. One of the most marked industrial developments brought about by the Council has, to a considerable extent, been due to the fact that the executive and technical officers of the industry have been in constant consultation with the scientific workers, and have been willing, as each progressive step was made, to have the experience of the laboratory tested out immediately on a commercial scale. Seven associate committees, working in closest contact with industry on the above lines, are now in full operation. Letters received from the industries co-operating in this way, indicating the value of the services rendered, have been exceedingly gratifying to the Council and its scientific workers.

The Council

The term of appointment of the following four members of the National Research Council expired on March 31, 1931, in accordance with the provision in the Research Council Act requiring that appointments be for a period of three years:—

A. Stanley Mackenzie, Ph.D., D.C.L., LL.D., F.R.S.C., President, Dalhousie University, Halifax, Nova Scotia.

J. C. McLennan, O.B.E., Ph.D., D.Sc., LL.D., F.R.S., Professor of Physics, Director of the Physical Laboratory, and Dean of the School of Graduate Studies, University of Toronto, Toronto, Ontario.

W. C. Murray, M.A., LL.D., F.R.S.C., President, University of Saskatchewan, Saskatoon, Saskatchewan.

Hume Cronyn, B.A., LL.B., General Manager, Huron and Erie Mortgage Corporation, London, Ontario.

There was also an additional vacancy in the membership of the Council at the beginning of the year under review because of the death, during the preceding year, of Dr. Henry M. MacKay, Dean of the Faculty of Applied Science at McGill University, as reported in the annual report of the National Research Council for 1930-31.

These five vacancies remained during the year 1931-32, but early in the following year they were filled by the appointment of the following:—

Frank Allen, M.A., Ph.D., LL.D., F.R.S.C., Head of the Department of Physics, University of Manitoba, Winnipeg, Manitoba.

H. R. Christie, B.Sc. F., Head of the Department of Forestry, University of British Columbia, Vancouver, British Columbia.

J. T. Foster, Vice-President, Trades and Labor Congress of Canada, and President, Montreal Trades and Labor Council, 747 Stuart Avenue, Outremont, Quebec.

F. M. G. Johnson, M.Sc., Ph.D., F.I.C., F.R.S.C., Dean of Science and Director of the Department of Chemistry, McGill University, Montreal, Quebec.

O. Klotz, M.B., M.D., C.M., F.R.C.P., Professor of Pathology and Bacteriology, University of Toronto, Toronto, Ontario.

The four members of the Council who retired on March 31, 1931, were members of the National Research Council from its inception.

Mr. Hume Cronyn, as a member of parliament, was one of those whose efforts helped in bringing about the creation of the Council and in establishing its activites. As chairman of the Parliamentary Committee which reported favorably on the proposal to establish a national research institute, he did valuable service for science. It is a source of great regret that the condition of his health prevented him in recent years from continuing his active association with the work of the Council and has now forced his retirement.

Dr. W. C. Murray, President of the University of Saskatchewan, throughout the days when the Council had to struggle for its existence, proved himself a wise counsellor and a source of strength and inspiration. He will be greatly missed by all those who have been associated with him in the Council's service.

Dr. J. C. McLennan, who retired from the Council because he has retired from active university work and is no longer living in Canada, was not only an energetic supporter of the Council, but one of the ablest of Canadian scientific workers. He will be missed from the Council and from scientific circles in Canada.

Appointments to the Staff

Upon the recommendation of the Research Council, approved by the Royal Commission on Technical and Professional Services (Mr. E. W. Beatty, chairman), and by Order-in-Council, the following grades for the professional staff of the National Research Laboratories have been established:—

Title	Qualifications or Equivalent	
	Degree	*Professional experience*
Director, the Division of Physics (or Chemistry or Biology, etc.)	D.Sc. or Ph.D.	10 to 15 years
Assistant Director	Ph.D.	10 years
Research Physicist (or Chemist or Biologist, etc.)	Ph.D.	8 years
Associate Research Physicist (or Chemist, or Biologist, etc.)	M.Sc.	5 years
Assistant Research Physicist (or Chemist or Biologist, etc.)	M.Sc.	2 years
Junior Research Physicist (or Chemist or Biologist, etc.)	M.Sc.	

At the end of the year under review the professional staff of the National Research Laboratories totalled 52. The fact that of these 26 are holders of doctorate degrees in science and others have qualifications in experience equivalent thereto, indicates the quality of the corps of investigators that the Council is bringing to the service of the state.

The following appointments were made to the professional staff during the year:—

Division of Chemistry

W. C. Davis, B.Sc., Queen's University; three years with British American Nickel Corporation; two years with the American Smelting and Refining Company, Peru; two years as independent assayer; one year of research on magnesian products; Junior Research Chemist, engaged in general analytical work.

W. Gallay, B.A., M.Sc., Ph.D., McGill University; as a holder of scholarships has studied in Germany under eminent colloid chemists; has published seven scientific papers; Assistant Research Chemist, engaged in various branches of colloid chemistry, including investigations of starch and leather.

N. H. Grace, B.A., M.A., University of Saskatchewan; Ph.D., McGill University; four years instructor in chemistry and engaged in research, University of Saskatchewan; Assistant Research Chemist, engaged in work on apple dehydration.

F. Gordon Green, engineering certificate, Mount Allison University; B.Sc., McGill University; three years as plant superintendent with oil shale plants, the Anglo-Persian Oil Company, near Moncton, New Brunswick, and the N.-T.-U. Company in California; three years as assistant to consulting engineer, Brooklyn, N.Y.; four years chemical engineer and research chemist, International Combustion Corporation, Milwaukee and Newark; Associate Research Chemist, engaged in chemical engineering and equipment of National Research Laboratories.

L. M. Pidgeon, B.A., University of Manitoba; M.Sc., Ph.D., McGill University; B.Sc., Oxford University; six years of university research in Canada and England; has published seven scientific papers; Assistant Research Chemist, engaged in research in physical chemistry.

A. van Winsen, mechanical engineering certificate, Technische Hochschule, Zürich; four years engineering experience in Tokyo, Japan; two years instructor in the Shawinigan Technical Institute, Shawinigan Chemicals, Ltd.; three years with Canadian Johns Manville Company; Junior Research Chemist, engaged in asbestos research and the standardization of testing machines.

Division of Physics and Engineering

L. E. Howlett, B.A., University of British Columbia; M.A., Toronto University; Ph.D., McGill University; 1927-29, Research Assistant to Prof. J. C. McLennan, F.R.S.; 1929-31, Research Assistant to Prof. A. S. Eve, F.R.S.; Junior Research Physicist, engaged in investigations in photometry, colorimetry and spectroscopy and in the use of optical methods for high temperature calibration and standardization.

A. J. Grant, B.Sc., McGill University; eight years with the meter engineering department, Westinghouse Electric Company; Associate Research Physicist, engaged in: (1) research necessary on the characteristics of all new types of meters sent in to the Council for approval as to type; (2) precise electrical measurements and standardization; (3) superintending an investigation on the re-seal period of electric meters.

W. A. Steel (Lt.-Col.), B.A.Sc., Toronto University; three years construction engineer, Eastern Ontario Power System; with the Canadian Expeditionary Force during the war, in charge of radio for the Canadian Corps; one year on radio research, University of Toronto; eleven years Chief Technical Officer, Department of National Defence, developing a radio system for aircraft forest patrol in western Canada, and in charge of all communication work for civic airways and the air mail system in Canada. Research Physicist, engaged in radio research. Colonel Steel has been the official Canadian delegate at four international radio conferences, and has either jointly or alone brought out two important radio inventions. He is the author of several papers on the subject of radio and radio development.

Division of Research Information

J. Stanley, B.A., University of British Columbia, M.A. and Ph.D., University of Minnesota; two years as research assistant in entomology, University of Minnesota; one year at experiment station of the Association of Hawaiian Pineapple Canners, University of Hawaii; three published papers; Junior Research Investigator, engaged in editorial work (from April 1, 1932).

It is of interest to note that 18 members of the professional staff received some of their postgraduate training as holders of National Research Council scholarships. Nineteen institutions of learning are represented in the professional staff: eleven in Canada; four in Great Britain; two in Switzerland; one each in the United States and Czechoslovakia. Forty-one members of the professional staff received their undergraduate training in Canadian universities. Certain graduates of foreign universities, resident in Canada, have been appointed to the professional staff in part because of their special qualifications in languages.

Associate Committees

Once again the Council desires to put itself on record as appreciating profoundly the co-operation which it has received from the staff members of the universities and colleges of Canada. Although co-operation in carrying on research work in the university laboratories with the assistance of the Council has been an important contribution, more important still has been the contribution made by the representatives of the universities in participating in our committees and giving their counsel and assistance in the organization and development of the larger co-operative researches that have been undertaken. Much of the work done could not possibly have been accomplished otherwise.

At the present time on the 30 associate committees, which are co-operating with the Council, are 297 individuals giving their time and thought free of charge in helping to organize and direct important researches. This is a most important contribution to the scientific and industrial development of Canada. On these committees there are 98 representatives of industry.

Two new committees were organized during the year. One was formed for the purpose of studying the effect of iodized salt in nutrition in connection with the health of the animals using it, and to determine, if possible, methods of securing a uniform mixture of the iodine with the salt. On this committee some of the leading pharmacologists of Canada are co-operating. A second committee was formed to investigate possible sources of helium in Canada. This committee was organized at the suggestion of the British Air Ministry acting through the Department of National Defence. The Department of National Defence, the Department of Mines and the Research Council are co-operating in this study.

In addition the Council authorized the organization of two other committees. The first of these deals with agricultural research. On this committee the deans of all the agricultural colleges in Canada, representatives of the Canadian Society of Technical Agriculturists and representatives of the Federal Department of Agriculture are co-operating with the National Research Council. The purpose in organizing this committee was to bring together in one group the directors of research organizations in agriculture, in order that a common program might be established to deal with the larger scientific problems which the agricultural industry presents. It is intended that this committee bring under review all the scientific work in agriculture and biology which is undertaken by the Research Council. A second committee deals with parasitology. The Council reports with pleasure that the arrangements suggested in the last report for co-operation between the Empire Marketing Board and the National Research Council in the establishment of an Institute of Parasitology at Macdonald College have been completed, and the actual work of investigation under the auspices of the Institute is

about to begin. An Associate Committee on Parasitology has been established consisting of representatives of Macdonald College, the Federal Department of Agriculture, and the National Research Council to direct the enterprise.

Assisted Researches

On page 136 will be found a list of the assisted researches in progress during the year, and on pages 108-132 reports thereon. Of these many were a continuation of reseaches previously begun. The new grants made during the year were:—

Grantee	Subject
Dr. W. P. Thompson	Seed setting in alfalfa.
Dr. H. R. Thornton	Problems in dairy research.
Prof. M. C. Herner	Barley as a food for poultry.
Prof. Edgar Stansfield	Fundamental researches on coal.
Dr. R. R. McKibbin	Means of releasing the potential fertility of Quebec podsol soils.
Prof. H. W. Price	Development of automatic speed control equipment for wind tunnels.
Mr. G. L. Godel	Field experiments with chemical herbicides.
Mr. W. H. J. Tisdale	Special grading of wool.
Associate Committee on Field Crop Diseases	Testing rust-resistant wheats.
Associate Committee on Field Crop Diseases	Breeding and selection of disease-resistant barleys.
Associate Committee on Grain Research	The relative feeding value of wheat, oats, barley and corn.
Associate Committee on Grain Research	Special equipment for drying grain.
Associate Committee on Radio Research	The reflection of radio waves at the time of the total eclipse.

Postgraduate Research Scholarships

Three classes of scholarships are awarded by the National Research Council; namely, bursaries, studentships and fellowships, having an annual value of $750, $1,000 and $1,200 respectively. Owing to drastically reduced appropriations available for scholarships, the Council found it necessary to temporarily reduce the amount payable to grantees to $500, $750 and $1,000, respectively, but it is hoped that these awards will revert to their original values when the present difficult period has passed.

These awards are intended to enable students who have graduated with distinction from a university to continue their training in science until they have qualified for a Ph.D. degree, three years being the maximum assistance granted to an individual candidate under any combination of awards.

These scholarships are awarded to the best qualified applicants therefor. The minimum qualification for a bursary is graduation with distinction from an approved university. An applicant for a studentship must have had at least one year of postgraduate research experience, while fellowships are awarded only to persons who possess very high qualifications and who have demonstrated beyond question their ability to carry on independent research.

During the fifteen years ending March 31, 1932, the National Research Council awarded 294 bursaries, 210 studentships and 84 fellowships. These 588 awards were held by 350 persons in 18 departments of science at 12 Canadian universities. Each grantee carried on his work under the direction of a member of the staff of the university where the award was held, who had agreed to co-operate with the Council in the careful supervision of this work. Three hundred and thirty-three grantees have secured the degree of M.A. or M.Sc., and 183 the degree of Ph.D. According to the latest returns which it has been possible for the Council to secure, 1,336 scientific papers have been published by these grantees.

By the end of the fiscal year, 1931-32, 300 persons had completed their training in science under these awards. The Council has therefore during the past 15 years increased to this extent the number of research workers available for service in Canadian industries and universities or in the government service. Of these, 181 persons held a bursary, studentship or fellowship for one year, 105 persons held awards for two years and only 64 held awards for three years.

It will perhaps be of interest to note the present occupation of the 300 persons who have completed their training under these awards. Of these, 30 persons are continuing their postgraduate studies, some under scholarships from other sources and some having gone to foreign universities for special instruction or in order to continue their training in some particular department of science; 76 persons are engaged in the teaching profession, 70 of these having received appointments to the staffs of Canadian universities, where the majority of them will have an opportunity of continuing their scientific training and of engaging in research work. Fifty-four persons are employed in the industries and 52 have accepted positions in the technical branches of the federal and provincial governments. Twenty-one grantees are employed in various capacities on the staffs of the university and other laboratories, and 14 persons for various reasons are not at present actively engaged in research work. Three grantees have died and 50 have failed to furnish the Council with information regarding their present occupation.

Physical Testing Laboratories

During the year under review the Physical Testing Laboratory of the Department of the Interior, with staff, was transferred to the Council. The work done in this laboratory naturally formed a part of the standardizing work for which the Council is responsible and therefore fitted easily into the Council's laboratory system. While the Council was glad to undertake this additional responsibility the extra burden upon its finances, since no special provision was made, created some difficulty.

Electricity and Gas Inspection Laboratories

Under the provisions of the Gas Inspection Act and the Electricity Inspection Act, the responsibility for setting up final standards in connection with gas and electricity measurement was placed upon the Council, so that

the work done in the laboratories of the Electricity and Gas Inspection Branch of the Department of Trade and Commerce became intimately associated with the work of the Council. It was deemed wise, therefore, in planning the National Research Laboratories, to make provision for placing the Electricity and Gas Inspection Laboratories in the Council's laboratory system. Plans for this have been completed and these laboratories will be transferred to the new building as soon as it is ready for occupation.

Testing of Oil Burners

During the year under review the possibility of testing oil burners and other fire equipment for use in Canada was brought to the fore. Up to the present an anomalous situation has existed. To effect the sale of all such equipment even though manufactured in Canada, and at the same time secure minimum insurance rates, it has been necessary to secure the approval of laboratories which were located outside Canada and not under the control of Canadians. A conference of interested parties was held at Ottawa and the problem was discussed with the Executive Committee of the Canadian Fire Underwriters' Association. The general policy was laid down that as soon as it was possible for the National Research Council to undertake the making of the required tests in this field the work should be arranged for in the National Research Laboratories. The testing of oil burners was urged upon the Council with particular force and, by direction of the Committee of the Privy Council on Scientific and Industrial Research, steps were taken to establish oil burner testing laboratories in the laboratory system of the Council.

Special Reports

During the year approximately 50 special reports have been prepared by the Division of Research Information on subjects on which research was contemplated or in progress in the National Research Laboratories, or on which inquiries had been received from industrial firms and various organizations. Of special interest at the present time is a report on "The Utilization of Agricultural Surpluses and Wastes". This report furnishes the statistical basis upon which any investigation must be founded and suggests a number of laboratory investigations which may be undertaken when facilities are available.

International Activities

It will be recalled that in 1929 the National Research Council was authorized to invite the Pacific Science Congress to meet in Canada in 1932. This Congress is a body which meets every three years for the purpose of establishing co-operation in seeking the solution of scientific problems of the Pacific area. Because of the general economic situation it was decided late in 1931 to postpone the meeting of the Congress in Canada for one year. It is expected that the Congress will meet in Victoria and Vancouver in June, 1933.

In accordance with its established policy of avoiding duplication of effort and of keeping in close touch with research centres elsewhere, especially within the Empire, the Council has taken out sustaining membership in several British research organizations and is therefore kept fully informed of their activities. These include the Wool Industries Research Association, the

British Leather Manufacturers' Research Association, the Linen Industry Research Association and the Association of Special Libraries and Information Bureaux. In addition affiliation is maintained with the International Chemical Union, the International Union of Pure and Applied Physics, and the International Committee on Annual Tables of Constants.

The President of the Council attended in September, 1931, the Centenary of the British Association for the Advancement of Science, on which occasion there were also celebrated the one hundredth anniversary of Faraday's discovery of the principle of the electric dynamo and of the birth of Maxwell. The International Illumination Congress, held about the same time, was attended by the President and by Dr. R. W. Boyle, Director of the Division of Physics and Engineering, who was in Europe at that time on annual leave.

Summary of Financial Statement for 1931-32

The parliamentary appropriation provided for the work of the National Research Council during the year under review was $500,000. It was the desire of the government, however, that expenditures be kept at a minimum and as a result only $469,771.78 was expended from the parliamentary vote. The Council received, during the year, from various sources other than the parliamentary appropriation, a total sum of $78,832.41, making a gross revenue for the year of $556,832.41, as compared with a total of $550,373.43 the previous year.

The monies from sources other than parliamentary appropriation were received mainly from trust funds held by the Council, from contributions made by industrial organizations toward work carried on by the Council, from fees for tests carried out in the National Research Laboratories, from the sale of publications, and from unexpended grants in aid of research made in previous years and recalled by the Council. The largest item of such revenue was the sum of $20,233.06 received by the Associate Committee on Grain Research from the trust fund established in 1928 for grain research. The sum of $5,816.20 was received from the Consolidated Mining and Smelting Company for investigations carried out on its behalf. The sum of $5,000.00 was contributed by the Sun Life Assurance Company of Canada as the final instalment of a grant of $50,000, paid over a five-year period to aid in the work of the Associate Committee on Tuberculosis. The sum of $4,200.00 was received from the Canadian Refractories, Limited, in connection with work carried out on the problems of that industry. The sum of $7,352.98 was received by the Canadian Engineering Standards Association, which operates as an associate committee of the National Research Council, this amount being derived mainly from contributions from industrial organizations toward the work of the Association. The sum of $2,007.62 was derived from the sale of publications. The sum of $29,332.33 was received from the cancellation and adjustment of research grants to associate committees and individuals.

The gross expenditure of the Council during the year under review totalled $548,604.19. Of this sum $166,898.05 was expended on grants in aid of research. This expenditure included grants to associate committees directing large co-operative investigations, grants to aid individual investigators in carrying out approved researches by furnishing them with either special apparatus required for the investigations or junior assistants, and other direct contributions toward the promotion and co-ordination of research work in Canada.

The sum of $38,490.00 was expended on postgraduate scholarships. The amount expended on scholarships during the preceding fiscal year was $59,335.00. The Council also expended, during the year, on additions to its library and on the publication of scientific information, including the Canadian Journal of Research, the sum of $25,722.70, and the sum of $27,391.75 was expended for equipment and supplies required for the maintenance of the National Research Laboratories.

Travelling expenses paid by the Council totalled only $13,914.45, of which expenditure $10,747.86 was incurred by members of the National Research Council and by its staff, and the sum of $3,166.59 was expended in the payment of travelling expenses of the members of various associate committees established by the Council for the purpose of directing the co-ordinating research work on major problems. The cost of the administration of the entire organization, including the provision of supplies, etc., totalled during the year $16,270.85.

Financial Statement for the Fiscal Year Ending March 31, 1932

S. P. EAGLESON, *Secretary-Treasurer*

Gross Receipts

From Parliamentary Appropriation	$ 478,000.00	
Contributions from Industry	15,016.20	
Canadian Engineering Standards Association	7,352.98	
Grain Research Trust Fund	20,233.06	
Test Fees	1,908.02	
Sale of Publications	2,007.62	
Refunds from Assisted Researches	31,644.72	
Miscellaneous	669.81	
		$ 556,832.41

Gross Expenditures

Assisted Researches	$ 166,898.05	
Scholarships	38,490.00	
Laboratory Maintenance and Equipment	38,156.87	
Publication	14,957.58	
International Affiliations	3,935.66	
Travelling	13,914.45	
Administration	12,335.19	
Salaries and Honoraria	259,916.39	
		$ 548,604.19
Refunded to Receiver General		8,228.22
		$ 556,832.41

Detailed reports of the work of the National Research Council follow.

REPORTS OF LABORATORY DIVISIONS

The following reports of the laboratory divisions have been prepared by the directors of those divisions to indicate the character of the investigations now in progress in the National Research Laboratories.

DIVISION OF BIOLOGY AND AGRICULTURE

R. NEWTON, *Acting Director*

The work of the Division of Biology and Agriculture during the year was continued under a co-operative arrangement at the University of Alberta. All of it has been intimately connected with the programs of the Associate Committees on Field Crop Diseases, Grain Research, and Weed Control, representing for the most part fundamental phases of these programs. Some of it will be transferred to the new laboratories at Ottawa during the coming year. The division will, however, maintain the close relations already established with various universities and other institutions, and will no doubt develop new contacts as the need arises and financial resources permit. Work which depends largely on field contacts in special areas will, it is expected, be continued in local centres as at present, but it is hoped that the divisional laboratories at Ottawa may be so well manned and equipped as to be in a position to attack problems which are beyond the scope of existing laboratories.

Chemicals as Herbicides

W. H. COOK

About 80 chemicals are being tested with the object of finding cheaper and more effective herbicides than those now in use. It was originally planned to test these chemicals by spraying them on four annual and four perennial weeds grown in the greenhouse. The work carried out during the past year has, however, been restricted largely to annual weeds. It is now planned to select from this group the more effective chemicals and test the toxicity of these on perennial weeds.

Sodium chlorate and sulphuric acid have been used as the bases for comparing the effect of new chemicals. It has been found, in the experiments conducted so far, that other mineral acids, such as nitric and hydrochloric acids, are as effective as sulphuric acid for killing annual weeds. Acids having strong oxidizing properties, such as selenic and chloric acids, are more effective.

Other inorganic chemicals which appear to be equally or even more toxic to annual weeds than sodium chlorate include arsenic pentoxide, sodium arsenite, sodium dichromate, ammonium thiocyanate, sodium selenite and zinc chloride.

Since sodium dichromate appears to be about as toxic as sodium chlorate, another strong oxidizing agent, potassium permanganate, was tested. This, however, was much less effective, so it cannot be concluded that strong oxidizing agents are all toxic to plants.

Organic chemicals which are highly toxic to annual weeds include formamide, formic acid, phenol, creosote, benzene, alpha-naphthylamine, and tetralin. Acid sludge is the only industrial by-product so far found sufficiently toxic to be useful as a herbicide. The work is being continued.

Fire Hazards in the Use of Oxidizing Agents as Herbicides

W. H. Cook

At present sodium chlorate is regarded as one of the best herbicides for eradicating perennial weeds. This chemical, in addition to its effectiveness, has the advantage of being comparatively non-toxic to livestock. Unfortunately, its admixture with organic matter yields a product which is highly inflammable, and commercial herbicides based on chlorates generally contain some other chemical, such as calcium chloride or sodium carbonate, to reduce the fire hazard.

As there was little precise information on this subject an investigation of the combustibility of mixtures of sodium chlorate and organic matter was undertaken. Cloth and filter paper were used as the test materials, and these were treated with sodium chlorate solutions of various concentrations, conditioned at various relative humidities, and then tested for combustibility in an apparatus devised for this purpose. When sodium chlorate formed more than 10% by weight of the conditioned material, it was found to be a distinct fire hazard at all relative humidities below 75%.

The investigation was then extended to study the effect of the addition of calcium chloride on the combustibility of the mixtures. As this chemical provides protection chiefly by retaining moisture, the extent of protection is dependent on the relative humidity of the atmosphere. It was found that a herbicide containing equal proportions by weight of sodium chlorate and calcium chloride was not a fire hazard at usual atmospheric humidities, although even this mixture (a much greater proportion of the latter than is ordinarily used) might become dangerous at the very low humidities which sometimes exist in the drier regions of western Canada. With the exception of magnesium chloride, water-absorbing chemicals failed to give as good protection as calcium chloride. Magnesium chloride appeared to be slightly superior to calcium chloride in reducing the combustibility.

Other chemicals which are known to have fire-resisting properties, apart from the mere retention of water, were also tested. Sodium stannate, used for fireproofing cloth, and ammonium phosphate, used for fireproofing wood, are examples of this class of chemical. None of these chemicals reduced the fire hazards of mixtures of sodium chlorate and organic matter as effectively as the water-absorbing chemicals. Other chlorates, such as calcium chlorate,* have also been tested.

Sodium dichromate is used to some extent as a herbicide, and as this is also a strong oxidizing agent the combustibility of varying proportions of this chemical and organic material was investigated. The fire hazard involved in the use of this chemical was much less marked than when similar amounts by weight of sodium chlorate were used. This is doubtless due to the dichromate salt having a much higher equivalent weight and also because it carries two molecules of water of crystallization. Nevertheless admixture of this

*So far as can be learned, true calcium chlorate for use as a herbicide has not been offered commercially. Mixtures of sodium chlorate and calcium chloride are sometimes misnamed "calcium chlorate" and sold as such.

salt in high proportions with organic material makes the mixture extremely inflammable. Mixtures containing large proportions of both sodium dichromate and sodium chlorate are extremely dangerous, yet a mixture of this sort is used in at least one commercial herbicide. Mixtures of potassium permanganate with organic material were non-hazardous, probably because the permanganate decomposed rapidly by the method employed for treating the test materials.

Weed Survey of the Prairie Provinces

J. M. MANSON

The weed survey of the prairie provinces, which was started in 1930 for the purpose of obtaining information for the Associate Committee on Weed Control, was completed in 1931.

The distribution of the more serious weeds has been studied and the locations of areas of various degrees of infestation outlined. Generally speaking, the older settled districts have the most serious infestations at present. However, many areas will have to face serious economic loss in the near future unless systematic attempts are made to eradicate the present small scattered infestations of such weeds as perennial sow thistle, Canada thistle, and stinkweed. These weeds are difficult to control, and eradication after a time becomes impossible.

A study has been made of the causes of weed spread and of possible economic means of combating some of the present agencies in dissemination. A report, together with maps, has been prepared for publication and is now in press.

Apparatus for Experimental Baking Test

J. G. MALLOCH AND W. H. COOK

Owing to the importance of the baking test in investigations in cereal chemistry it is desirable that the personal factor should be eliminated. This can be achieved only by mechanization of every step in the procedure. Machines for this purpose are not available commercially and they must, therefore, be specially designed and constructed. Two such pieces of apparatus are being perfected at the present time. One of these, a combined moulding and punching machine, will eliminate hand manipulation of the dough. The other, a color-scoring device, will eliminate personal judgment in scoring the color of flour and bread.

Phenolic Compounds of the Wheat Plant in Relation to Rust Resistance

J. A. ANDERSON

The main phenolic compounds present in wheat leaves are a series of flavone pigments, and the indications are that these occur most abundantly in rust resistant varieties. The fundamental compound of this series is a new pentahydroxyflavone, tricetin, which occurs in the leaves in small quantity as a water-insoluble dimethyl ether, tricin. There are also present, in very considerable quantity, two or possibly more water-soluble pigments.

Dyeing tests indicate that these are closely related to tricin and tricetin, and it is thought that they are glucosides of one or the other. Tricin and a preparation of the water-soluble pigments have been isolated from the resistant variety Khapli, and in much smaller yield from the susceptible variety Marquis. Dyeing tests indicate that the same compounds occur in varying amounts in all of six other wheat varieties tested.

The determination of the constitution of tricetin, the main problem in establishing the identities of the various phenolic compounds of the wheat plant, has now been accomplished. By splitting up the tricetin molecule into its component parts, identifying them, and resynthesizing the original compound from them, it has been shown that tricetin is 5 : 7 : 3′ : 4′ : 5′ —pentahydroxyflavone.

Methods have also been devised this year by means of which the water-soluble pigments have been isolated as a comparatively pure, semi-crystalline powder. The indications are that this powder is a mixture of two or more compounds. It has all the properties of a flavone glucoside but differs from those already described in its extreme solubility in water and resistance to acid hydrolysis. Further investigation of the powder has been postponed pending the isolation of a new supply.

The effect of common phenols, of phenols and other compounds isolated from the wheat plant, and of various host preparations, on the germination of rust spores, is also being investigated.

Studies on the Gluten Proteins

W. H. Cook

An account of the work on the preparation and denaturation of the gluten proteins outlined in the last annual report was published during the year in two papers in the Canadian Journal of Research. The object of this work is to determine the nature of the fundamental changes which occur in wheat and flour when these products are subjected to heat treatment, as in the commercial drying of wheat.

The earlier work on the viscosity changes of the gluten proteins in relation to heat denaturation is being continued. At present whole gluten dispersed in 30% urea solution is being investigated, but a study of the various gluten fractions will be undertaken later. This experiment will give information as to the rate of denaturation at different temperatures.

The use of a neutral dispersion agent, such as a urea solution, permits a study of the properties of gluten over an intermediate range of hydrogen ion concentration as well as at the extremes which alone were formerly possible. The behavior of gluten in the region of neutrality may be important from the standpoint of baking quality.

Nitrogen Metabolism in Cereals

A. G. McCalla

Numerous investigators have studied the nitrogen metabolism of ripening grain, and some have studied the non-protein nitrogen of green plants at various stages of development, but no one has hitherto investigated the relation between synthesis of proteins in the leaves and grain and the nitrogen supply.

In 1931 some preliminary experiments were carried out to test the possibility of making such a study. Although the main project is being carried out with wheat, these preliminary experiments were made with barley because of its resistance to mildew, which was very destructive to wheat under the prevailing conditions.

The plants are grown for the most part in complete culture solution, but for some of the plants in the later stages of growth the solution is nitrogen free. Samples are analyzed at intervals during the growth period. Since our knowledge of protein chemistry is still incomplete, it has been decided to study the proteins by means of their split products. The green plants are ground finely, and the protein and non-protein nitrogen fractions are separated by precipitation and filtration. The two fractions are then hydrolyzed, and the total, amide, mono-amino acid and basic amino acid nitrogen contained in each hydrolyzate are determined.

The preliminary experiments have given some indication that the following results may be expected: (1) While some reduction of nitrates takes place in the roots, relatively large amounts are translocated to the stems and leaves. (2) The greater part of the nitrogen in the plant is in the form of protein. (3) New growth is higher in percentage of total nitrogen than older tissues, provided there is an adequate supply of nitrates, but lower if nitrates are excluded from the culture solution. (4) When the plants are deprived of a nitrogen supply, the proteins in new tissues are built at the expense of older ones, the nitrogen sources being first the non-protein fraction, and then possibly that nitrogen bound in the proteins in the form of amides.

Comparison of Diastase from Wheat and Barley

J. G. MALLOCH AND A. M. TORRIE

Canadian wheat flours are often low in diastatic activity and the quality of the bread produced from them can be considerably improved by the addition of diastase. In commercial practice barley malt preparations are widely used for this purpose. In view of this it is desirable to know whether or not the enzyme present in barley is identical in properties with that present in wheat. Diastase preparations are being made from the two sources by four different methods. The effect of acidity, temperature, electrolysis, and dialysis on the activity of each preparation is being determined. Evidence has been obtained that the enzymes prepared from the same source by different methods differ markedly in their characteristics.

Statistical Analysis of Data Collected by The Associate Committee on Accurate Plot Work

J. W. HOPKINS

This project was completed during the year and a report submitted to the Canadian Journal of Research for publication. The differences in yield of oats resulting from variations in rate of seeding were generally small, but it was shown that the optimum rate for a given variety was not the same at different stations, but varied with soil and climatic conditions. It was also shown that only by "randomization" of plots can errors inherent in such field experiments, due to heterogeneity of soil, be overcome.

DIVISION OF CHEMISTRY

G. S. WHITBY, *Director*

Owing to the depression, it has not been possible to build up the staff of the division as far as had been planned, and as a result the number of men working in some of the major fields in which work was initiated when the laboratories were opened last year is hardly commensurate with the importance of the subjects in question. Despite shortness of staff, however, very definite progress has been made on a considerable number of lines of investigation. The main subjects to which attention was devoted by the division during the year are referred to in the sections which follow.

Magnesian Products

A. F. GILL, N. P. PITT, C. W. DAVIS

This investigation has been continued under the co-operative arrangement previously entered into with the operating companies, and with their financial assistance. Further acknowledgment will be found under the report of the Associate Committee on Magnesian Products, page 89.

Previous work pertaining to production problems and control of the properties of plastic magnesia was concluded, and efforts have been directed more towards the development of further markets and improvement of existing products.

In monolithic flooring, the main outlet for plastic magnesia, the most interesting commercial development was the installation of composition floors in the new National Research Laboratories. The plastic magnesia for this installation was manufactured under the supervision of the laboratory staff, and the staff also supervised the actual construction of the floors. As a result of the success of this installation a number of contracting firms have become interested, and a growing market for Canadian plastic magnesia in flooring is anticipated.

Further work has been done in the building-products field, investigations having been carried out in connection with special floors, pre-cast and laminated products. Arrangements have been made for commercial trials of a number of these, notably finishes for cork insulation and cast floor and wall tiles. While rapid development in this more specialized field will hinge on improvement in business conditions, steady progress is being made.

Chemical uses for the caustic material based on its magnesia content are being followed up. Materials have been supplied to one corporation for commercial trials of a new process, which if successful is expected to provide a market for a large tonnage. This laboratory, however, is taking no direct part in the commercial trials.

Some further information of a theoretical nature has been obtained which has been of practical use in the work on oxychloride cements.

During the latter part of the year the laboratory work was rearranged somewhat. Some investigations in the refractories field were undertaken following up work previously done by Mr. J. W. Craig in the Mines Branch Laboratories. The main problem was to effect improvements, if possible, in the refractory "cement" and "ramming mix" previously developed. Some

modifications have been made both in particle size and tempering liquids and successful installations have been made in several Canadian metallurgical plants. This work is being continued in collaboration with Mr. Craig.

Gas Research

A. Cambron, C. H. Bayley

The work in this field has for its primary object the development of processes which may lead to the commercial utilization of waste natural gas in western Canada. During the greater part of the present year the work was directed towards the production of olefines by the thermal treatment of the lower paraffin hydrocarbons above methane. These paraffins constitute about 24% by weight of the Turner Valley gas, and their conversion into olefines would provide a valuable raw material for the production of benzene and other aromatics by thermal treatment, or, by other processes, for the production of ethyl alcohol, ethylene glycol, isopropyl and butyl alcohols.

A process has been successfully developed by which the production of olefines by the thermal treatment of the lower open-chain paraffins, from ethane to heptane inclusive, can be carried out at a current consumption of 1·2 to 1·8 kw.h. per lb. of olefines, when electrical heating is used.

The successful development of the process was due in great part to the thorough study made of the character of the gas flow through heated tubes, the rate of heat transfer between the tube wall and the gas under conditions of streamline and turbulent flow, and the effect of these two factors on the temperature distribution within the reaction zone.

It has been found possible to obtain reaction conditions such that the deposition of carbon has been practically eliminated, and the temperature required for carrying out the reaction has been reduced to such a point as to permit the use of reaction tubes of special alloy steel such as are now commercially available, thus dispensing with the necessity for costly and fragile refractory tubes. It may be mentioned that carbon deposition and the high temperatures required have previously been the two determining factors in rendering impracticable the commercial production of olefines from the gaseous paraffins.

Since low-boiling hydrocarbons suitable for motor fuel are the most readily marketable products that can be produced from olefines, a study is now in progress for the purpose of determining the commercial possibilities of the conversion of olefines, such as are obtainable by the thermal treatment of the lower paraffins, into liquid hydrocarbons boiling in the gasoline range.

The preliminary results show that the use of a reaction tube such as that designed for the production of olefines from paraffins gives very promising results. From propane, for instance, yields of 2·6 gal. of liquid hydrocarbon boiling in the gasoline range have been obtained per 1,000 cu. ft. of paraffin treated and indications are that the yield can be increased to about 3·5 gal. per 1,000 cu. ft. by recycling the gas. This phase of the work has only recently been taken up, but sufficient data will soon be available to indicate the commercial possibilities of the process.

Production of diolefines. In connection with work on synthetic rubber which is being carried out in the National Research Laboratories, a supply of butadiene and isoprene was required, and it was thought of interest to investigate the production of these diolefines by the thermal decomposition of cyclohexane, cyclohexene and dipentene in the apparatus used for the conversion of paraffins into olefines.

A number of experiments were carried out with dipentene, but the work was discontinued after an adequate supply of isoprene had been obtained, on account of a more pressing problem. In view of the results obtained, however, it is proposed to resume this problem when time permits, with the particular object of determining the mechanism of formation of isoprene from dipentene, as this would throw light on the relative stability of the carbon to carbon linkage in the dipentene ring.

Experiments were also carried out on cyclohexane and cyclohexene. Yields of butadiene up to 57%, based on the cyclohexane treated, have been obtained. These yields are considerably higher than those hitherto reported in the patent literature. The present experiments were carried out with carbon dioxide as a diluent instead of steam which has been used by previous investigators.

Higher yields of butadiene were expected on subjecting cyclohexene to the same thermal tretment as cyclohexane. The yield of butadiene, however, was actually lower, and this was found to be due to the strong tendency of the unsaturated cyclohexene to undergo polymerization at the temperatures required for its conversion into the diolefine.

Asbestos

D. Wolochow, A. van Winsen

Tests on the spinning qualities of crude and spinning asbestos fibres were carried out in the textile departments of two large asbestos manufacturing plants with the co-operation of these two companies. Accurate data on the performance and yield of the different fibres at each stage of the manufacturing process were obtained and a complete report was submitted to the Associate Committee on Asbestos.

Work has been done on the standardization of the Quebec standard testing machine and on the standardization of testing procedure. A large number of tests were made on 15 different machines and the results were compared. To obtain dependable results a method of preparing uniformly mixed fibre batches has been developed. Deviations in tests of the various machines were then established and an attempt made to determine the causes of these deviations. A number of these causes were found and the machines were readjusted. It was shown that some relation existed between the deviations in test results and the mechanical characteristics of the Quebec standard testing machine; furthermore, the structure, material and condition of the screen cloth were found to have an important influence upon the test results. It was therefore decided to study the feasibility of a standard design of the testing machine proper as well as the standardization of the screen cloths. Considerable progress has been made along these lines.

Further studies have been made on the apparent density test for fibre and an experimental testing device has been designed and is at present being built. Preliminary experiments indicated that the apparent density test might be of value in determining the peculiar characteristics of various fibres, and it is hoped that it will be possible to correlate the results of this test with the behavior of the fibre in the manufacturing process for which it may be used.

Experiments are also being made with samples of fibre to determine the effect of time in connection with the storage of asbestos. A method for accelerated drying of asbestos fibre is being developed.

A process for the economic utilization of low-grade fibre and asbestos tailings has been worked out in the laboratory. Commercial tests will be made in the near future.

A method for making new moulded asbestos compositions has been developed, the distinctive feature of which is the wide range of physical properties which can be obtained. The products are entirely fireproof and can be made from any grade of fibre.

Some further work has been done on the bonding of asbestos fibre with Portland cement with the object of developing new products. The results obtained show that there are a number of possibilities in this direction; these will be followed up. In this connection there is under investigation a method for modifying the physical properties of Canadian fibre so as to widen its application in the manufacture of such products as asbestos-cement pipe.

Work has been undertaken looking toward the wider use of asbestos in asphalt pavements. The possibility of adding very short fibre to road tars is also being investigated.

High grade asbestos fibre has possibilities as a material for fishing nets and its use for this purpose is being studied.

Information has been gathered on the removal of magnetic iron from asbestos on which some preliminary experiments have been carried out.

The washing of fibre is being further studied.

Wool Research

P. Larose, Miss A. S. Tweedie

Wool from western experiments. Experiments on the effect of environmental factors on the growth of wool are being conducted by Prof. J. P. Sackville at the University of Alberta, and samples of the wool are being tested at Ottawa. Determinations of staple length, fibre length, crimps, fibre diameter, tensile strength, elongation, water-soluble matter (suint), ether-soluble matter (grease), dirt and yield of clean wool were made on 72 samples clipped in the fall of 1930 and 72 samples clipped in the spring of 1931. An equal number of samples clipped in the fall of 1931 were also tested for staple length, fibre length, crimps, tensile strength and elongation. These measurements involved a vast amount of detailed work.

The fleeces of sheep from various experimental flocks in the west were examined while they were being graded. Representative samples from various grades of wool and various breeds of sheep were taken to be tested in the laboratories.

Comparison of methods of measuring fibre diameter. An investigation into various ways of measuring fibre diameter is being made. The samples of wool were measured by the weight-length method in which the average fineness is determined from the weight of a known length of fibres. This necessitated the counting of over 75,000 fibres and the measurement of 7,700 of them. The other methods being investigated include the eriometer, the microscopic projection, the micrometer-calipers and the micro-balance methods. In this connection some experiments were also carried out to determine the extent of swelling of the fibres at different humidities.

Comparison of methods for determining grease, suint and dirt in raw wool. Some experiments were carried out with a view to finding the most suitable

laboratory method to use for the determination of grease, suint and dirt in wool. It has been found that an extraction of the wool by petrolic ether followed by washing in water is the best practical procedure, the dirt being obtained by filtration of the water washings after these have been boiled down to a very small volume.

Moisture absorption by wool grease. Tests have been made to determine the quantity of moisture taken up by wool grease at various relative humidities. These tests are still under way. No definite figures have yet been obtained but it has been found that absorption is a very slow and complex process. The quantity of moisture taken up by the grease has been found to be much smaller than that absorbed by wool at the same relative humidity.

Determination of sulphur in wool. Some analyses of Canadian wools for sulphur content were carried out by the use of a method not hitherto applied to wool. The results of these analyses showed very little difference between the amount of sulphur in coarse wool and that in fine wool. This is contrary to results which have been generally obtained elsewhere, but in agreement with the results of Marston in Australia. Moreover, the results obtained on Canadian wool show an average sulphur content which agrees with that found by Marston for Australian wools.

Effect of light on the sulphur content of wool. A few tests were made to determine the effect of sunlight on the sulphur content of wool. The samples were exposed to the light from an arc lamp in a fugitometer, which light approximates sunlight. The tests showed that on prolonged exposure the sulphur content in the wool decreased, due to decomposition. The ultra-violet rays are probably the most active in this respect.

Tests on the transparency of wool grease to ultra-violet rays showed that the coating of wool grease on wool is not sufficient to protect the wool from the action of these rays, although it would retard it appreciably.

Dried Apples

N. H. GRACE

Dried apples, as now generally available, lack many of the appealing characteristics of the fresh fruit. This investigation, carried out with the object of developing a method for the production of dried apples which will approximate closely to the fresh apples in flavor, has met with a very considerable measure of success, and it is hoped will be put into commercial operation in due course. The investigation has been made with the financial assistance of the company interested.

Honey

MISS H. D. CHATAWAY

The moisture content of honey is of great importance in regard to the spoilage of honey by fermentation, the production of a uniform, finely-crystalline honey for the export market, and certain other practical questions. Since a reliable, convenient and accurate method of determining moisture in honey was lacking, research was undertaken on the subject. In this work L. Skazin rendered assistance.

This research has made good progress and a paper embodying the results obtained appears in the May, 1932 issue of the Canadian Journal of Research, from which the following summary is taken:—

(1) A new method for the determination of moisture in honey, one dependent on viscosity, had been studied and found practicable.

(2) Viscosity, refractive index, and absolute moisture determinations have been carried out on 60 honeys.

(3) Based upon the above figures, tables have been drawn up which make it possible to determine moisture content simply and rapidly, either from viscosity or from refractive index measurements, with an error in all probability no greater than that of the standard A.O.A.C. method. However, buckwheat honeys, and possibly those which have become fermented, give abnormal results.

(4) The ground has been cleared by preliminary work for a study of the degree of accuracy obtainable with carefully designed honey hydrometers. Tests in a honey-shipper's factory showed that hydrometers as ordinarily used give inaccurate results.

With reference to the use of refractive index for determining the moisture in honey, it may be noted that special tables had to be worked out. Main's sugar tables, which have previously been used also for honey, were found to be inapplicable, although the inaccuracy of results based on them was less for diluted than for undiluted honey.

Some experiments on the development of new products from honey which may be of commercial value were undertaken.

Leather

W. E. GRAHAM

During the year under review inspections were made of several Canadian tanneries. Visits have been made to packing houses to discuss problems connected with the curing of hides, the production of oils and greases, and their application to leather. A visit was also made to a glue factory to discuss the utilization of chrome leather scrap for the manufacture of glue.

Using as a basis a questionnaire sent to packers, tanners and hide collectors in Canada, a report was prepared on warble fly damage to Canadian cattle hides during 1930. The survey which was made showed that the hides from at least 50% of all cattle slaughtered during 1930 were damaged by open holes or scars, with a total loss of nearly a million dollars. Copies of this report were sent to agricultural authorities and others interested in the warble fly nuisance and its elimination.

In view of the many methods proposed for accelerating the tanning process a Review of Methods of Rapid Tanning was prepared and distributed to the tanners. This report criticized the various methods proposed and endeavored to show what methods gave most promise of satisfactory application.

A review of the British Leather Manufacturers' Research Association's reports on vegetable tanning, with particular emphasis on methods available for tanyard control and on chrome tanning, has been in course of preparation

and will be distributed shortly. A report on a survey conducted on damage due to "red heat" on hides in transit from the Argentine to Canada was prepared and distributed to members of the Associate Committee on Leather.

A survey was made of the literature on the application of sulphite cellulose waste liquors in the tanning industry. This literature includes over 200 patents and journal articles, and a summary of the review has been distributed to members of the Associate Committee on Leather. The review is of greatest value in the laboratory as a guide in carrying out the work which is being undertaken on the utilization of the waste liquors from the sulphite pulp industry; very little information is available bearing directly on the applications in the tannery.

As there are estimated to be 5,000,000 lb. of chrome leather scrap available annually, which would be more valuable as glue stock if it could be completely and economically dechromed, laboratory work has been started on the removal of the chrome tanning material. A brief review of the literature has been prepared.

Numerous analyses of tanning liquors and leather have been made. Several of these analyses have been on experimental liquors and the resultant leathers from tanneries, and the tanneries concerned have discussed quite freely the details of their plant experiments. Work on the analyses of oils used in the leather industry has also been done.

Arrangements are being made to carry out investigations on vegetable tanning materials, the utilization of sulphite-cellulose waste liquors, and the application of oils and greases to leather.

Maple Products

L. SKAZIN

Further work has been done on the new non-hardening, non-mottling form of block maple sugar to which reference was made in the last report, and it is believed that the process is now ready for commercial exploitation.

Another new maple product which has been developed during the year is what may be called super-flavored syrup. By the process which has been worked out it is possible to produce, from a given sample of sap, syrup eight to twelve times as intense in maple flavor as that produced by the ordinary evaporators. Further experiments on this process are being conducted throughout the course of the 1932 sap season.

A new process is being worked out for the production of a concentrate of true maple flavor—a product which should be of value in ice-cream and confectionery manufacture. It is believed that the product is very markedly superior to that produced according to the only other known method of preparing such a concentrate, namely that claimed in U.S. Patent 1,642,789. This latter process uses heavy chemicals and high temperature, factors which tend to destroy to some extent the delicate maple flavor.

Work is also actively in progress on the development of a fourth new maple product.

Successful experiments have been carried out on the treatment of dark colored, caramelized maple syrups, with the object of rendering them paler and improving the flavor.

Refuse Screenings

C. Y. Hopkins

The problem of disposal of the refuse screenings which accumulate at the head of the lakes has become more serious during the past year, and the investigation has been continued. The mixture of weed seeds has been analyzed to determine the quantities of each seed available and a general method for separating starchy seeds from oleaginous seeds has been devised.

The extraction of oil from the seeds has been studied and methods of expression and solvent extraction were compared, as well as the use of different solvents. Preliminary experiments were carried out on refining and conversion to soap. Oils from the following seeds have been examined to determine their physical and chemical constants and their drying properties: hedge mustard, wild mustard, tumbling mustard, hare's ear mustard, mixed weed seeds from screenings. A complete analysis of the fatty acids from the last-mentioned oil seed has been undertaken and the results indicate a marked similarity between this and other oils of the *Cruciferae*, notably rapeseed oil.

While there is not a great demand for oils of this type in Canada, attention has been directed to extending their use in lubricants, in the leather industry, and in insecticidal sprays for fruit trees.

Brief reports have been issued on the use of weed seeds in feeding-stuffs and on the manufacture of industrial alcohol from refuse screenings.

Rubber

M. Katz, D. F. Stedman, T. R. Griffith

Samples of synthetic rubber from dimethyl-butadiene, prepared by polymerization at room temperature and at 45° C., respectively, were subjected to vulcanization tests in comparison with natural rubber. In an accelerated gum stock containing 3% of sulphur the cold polymerized methyl rubber gave vulcanized products less than one-third as strong and only about one-third as extensible as natural rubber. The addition of carbon black greatly increased the strength of the synthetic rubbers, rendering both about half as strong as natural rubber in a similar stock. The methyl rubbers were slower to retract at room temperatures. Increase of temperature improved their speed of retraction but seriously reduced their breaking strength, so that at 70° C. the specimens were practically devoid of tensile strength. In general the synthetic rubbers were much more sensitive to change of temperature than natural rubber.

An account of the work was published in the Canadian Journal of Research, 6: 398-408. 1932.

Specimens of synthetic rubber, prepared from isoprene and butadiene by emulsion polymerization, possessed a much higher apparent molecular weight than synthetic rubber prepared by simple heat polymerization. This work is being continued.

Work on the mathematical investigation of curves obtained in tensile tests of rubber has been continued, giving particular attention to a type of curve which has been found to give a sharp break in the middle of the stretch. No explanation is as yet offered for this break, but it is hoped to obtain some information of value in elucidating the structure of rubber, and possibly also of similar polymers.

A stress-strain curve for rubber has been deduced mathematically, based on a fundamental assumption for the structure of rubber. It is also possible to deduce theoretically the percentage of sulphur necessary for vulcanization, and the theoretical result is in agreement with practice. Other points are brought out which throw considerable light on the structure of rubber. The work will be published in due course.

Straw

L. MARION

Work has been initiated with the object of securing certain fundamental information concerning straw which may be of value in a more extensive program of research on the utilization of straw which it is proposed to undertake when staff permits. In particular the lignin of straw is being studied.

By extraction with methyl cellosolve and dioxane, in conjunction with hydrochloric acid, lignin has been extracted from wheat and oat straw, the amount recovered being 7 to 8% in the former and 11 to 12% in the latter case. At the temperature of boiling water straw loses about 40% of its weight in the extraction. By means of differences in solubility the lignins obtained have been separated into five fractions. Two main middle fractions, soluble in acetone and methanol respectively, and apparently related, have been obtained. Lignin obtained from straw by the extractants mentioned is a compound of lignin with the solvent. A comparative study has also been made of lignins obtained from various other plants, and these products have been found to possess different chemical and physical properties, depending on the raw material used.

The residue left from straw after extraction with methyl cellosolve, can, after a very mild alkali treatment, yield cellulose requiring remarkably little bleaching.

Carbon Black

D. F. STEDMAN, L. M. PIDGEON

For this investigation a photometer has been constructed which permits direct comparison between a standard white and the black under examination, and it is hoped in the near future to develop this method of classifying blacks. A furnace has also been constructed with which an endeavor will be made to obtain valuable data on the mechanism of production of carbon black. This furnace permits the carrying out of pyrolysis experiments at any temperature up to about 3000° C. Experiments will be carried out before long on the production of carbon black in this furnace.

Laundering

O. M. MORGAN

In continuing the program of laundry research, laboratory experiments have been completed on preparation of a satisfactory standard soiled cloth for the measurement of the efficiency of washing operations. Using a small wash wheel the effect of soap concentration, temperature, time of washing, speed of the wheel, reversing the wheel, and changing the number of revolutions before reversal, has been investigated, and the results have been published in the Canadian Journal of Research, 6: 292-305. 1932.

Work similar to the above has been completed using built soaps (soaps plus alkali). Washing experiments using 0·1% soap solutions with additions of the various alkalies have been completed and their detergent efficiencies in equivalent concentrations compared. Power laundry tests of a similar nature are now under way. Measurements of pH were made on all washing solutions and in this connection a wide range of buffer solutions was prepared, as also a mercury purification tower and air-blast still.

A series of detergent tests was run in Vail's Laundry, Ottawa, in collaboration with Swift and Company of Chicago. These tests investigated the efficiency of washing and the effect of the present methods used on colored articles. The results were highly satisfactory.

Another series of detergent tests was run, using the launderometer, in collaboration with the Detergents Committee of the American Oil Chemists' Society. These tests showed that in equivalent concentrations tallow soap is slightly superior to coconut oil soap.

Service work for the industry has occupied a considerable amount of time. A total of 253 service reports have been issued during the past year. The reports have covered a wide range of subjects, for example, diagnosis of textile damage, analyses of textiles, soaps, alkalies to be used as soap builders, water, dry cleaning solvents, bleach liquors, corrosion tests on metals and issuance of technical information to teachers and laundry advertisers.

Effect of Oil on Canvas

O. M. Morgan

At the instance of the Department of National Defence there was carried out an investigation of the effect of oils on cotton duck tenting material. The results of this work were published in the Canadian Journal of Research, 6: 306-308. 1932. Vegetable oils were shown to have greater deteriorating action than mineral oils. Cottonseed oil produces the greatest weakening effect, giving tensile strength losses of 73% during a 240-day weathering exposure. There are indications that the tensile strength losses are proportional to the iodine values of the oils, but this has not been definitely established. Mineral Khaki has a very definite weather-proofing and oil-resisting action when impregnated in cotton.

Stump Destruction

M. Katz

Preliminary experiments were carried out on the destruction of tree stumps by various methods involving the use of chemicals and by burning. Chemical reagents of the type known to react with finely divided wood in the laboratory were found to be either unsatisfactory or too costly when applied to stumps in the field. A burning process using a stump-burning outfit consisting of a heavy gauge sheet iron cylindrical furnace of suitable size, equipped with a long draft pipe at the base and a chimney at the top, was found to be practical and efficient, when a blast of about 250 cubic feet of air per minute was supplied by a power-driven blower attached to the draft pipe. Certain chemicals were found to be effective as aids to combustion.

Battery Separators

L. M. PIDGEON, D. F. STEDMAN, C. H. BAYLEY

Most of the storage batteries manufactured in Canada for motor car use are fitted with separators made from Port Orford cedar, a wood native to Oregon. The British Columbia wood yellow cypress (or cedar) has appeared to be suitable for this purpose but has not received much attention from battery manufacturers.

Preliminary work by Dr. D. F. Stedman and C. H. Bayley indicated that yellow cypress maintained its strength in sulphuric acid as well as does Port Orford cedar, and a thorough investigation seemed desirable. A program of research was started which included the determination of their relative mechanical strength, resistance to the action of sulphuric acid, porosity and electrical resistance. A number of tests were devised to determine the mechanical strength of separators under conditions similar to those taking place during normal operation of the battery. Attention has been paid to the effect on the separator of the reaction attendant on charging the battery. The tests are in progress. Foaming in the battery during charge with resultant loss of acid and corrosion of adjacent parts is a trouble experienced in some cases, and this is now being studied.

Colloids

W. GALLAY

Velocity of creaming of milk. The effects of various hydrophilic colloids, both proteins and carbohydrates, on the velocity of creaming of milk, was briefly studied, and the results may be summarized as follows: Agar and gum tragacanth were found to have particularly large accelerating effects, the effectiveness decreasing in the order—gum arabic, gelatin, starch and dextrin. The coagulation was shown to consist of two large factors, *viz.*, (1) that of the adsorption of the protective colloid (calcium caseinate) by the added colloid, and (2) that of the dehydrating effect on the protectant. Further, a lesser electrical effect was indicated in the reduction of the potential of the protectant, bringing it closer to the critical one of flocculation.

Experiments involving attempts to use cream of comparatively low fat content for whipping purposes, with the aid of added colloids, yielded rather disappointing results, the differences obtained being small.

The fixation of tannic acid by various proteins and the accompanying swelling action. The taking up of tannic acid from aqueous solution by gelatin and casein was found to follow the adsorption law, the quality and intensity factors both varying widely for the two adsorbents, showing different surface effects. No possibility of compound formation was indicated. The temperature coefficient of adsorption was also determined in the case of gelatin. In the case of hide powder as adsorbent, a maximum of fixation at intermediate concentration was obtained. Both in the latter reaction and in experiments carried out with varying pH, sorption was found to run parallel with swelling. This was found to hold also in the sorption of sodium hydroxide by hide powder. Inorganic salts, added before and after adsorption, showed no Hofmeister series in their action. The effect of a series of acids on the sorption at the same pH was shown to be that of their swelling action upon the protein.

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In the case of alcohol-water or acetone-water as solvent, however, the sorption was found to be solution according to Henry's law. The effect of compound formation between alcohol and water was also directly shown upon the sorption.

Upon the basis of the above experiments, the following conclusions were drawn: The Procter-Wilson theory of vegetable tanning, assuming a mutual coagulation between positively charged protein and negatively charged tannin, has many serious defects. The results may be explained by considering the fixation of tannin on protein as a sorption, consisting of a physico-chemical adsorption and a physical absorption or solution. Only the latter factor remains where the surface effect can be eliminated. The effect of other factors, chiefly those of change in pH and presence of a non-electrolyte, can be explained on the basis of the change in the degree of swelling causes, physical solution and physico-chemical adsorption varying directly with the swelling.

Distillation

D. F. STEDMAN

A detailed study has been made of the new type of distilling column mentioned in the fourteenth annual report, with a view to increasing its efficiency to the maximum. It has been found possible to nearly double the height efficiency of the column at present in use, and an investigation of Turner Valley naphtha has been started.

The column at present set up has been used to make a study of hexane as a preliminary to the larger operation on Turner Valley naphtha, and each hexane, except the tertiary member, has been isolated in almost complete purity, starting with only 2500 cc. of hexane.

This column has also been used to make a distillation analysis of the reference fuels used for knock rating of gasolines. The octane, 2-2-4, trimethyl pentane, was 98·66% pure, while two samples of the *n*-heptane were 99·49 and 99·77%, respectively. In this connection it is interesting to note that the principal impurity in the *n*-heptane is *n*-hexane. This has not previously been isolated from a plant source.

A sample of cyclo-hexane was also distilled for other purposes, and the freezing point of the purified material appeared to be ·17° C. higher than the internationally accepted value. This would indicate that the standard pure material still contains ·05% impurity.

In connection with this work it was also necessary to make a close study of methods of testing columns, and while this is not yet complete considerable improvement has been made.

McMurray Bitumen

M. KATZ, T. R. GRIFFITH

Work was carried out on the treatment of bitumen from the McMurray tar sands of Alberta at elevated temperatures with air and catalysts, in order to develop a product which would disperse easily in rubber and have a consistency such as to make it suitable for use as a compounding ingredient of the mineral rubber type. It was also hoped that the information secured would be useful in developing a product suitable for the paint trade as well

as for moulded products. After considerable experimentation a blown bitumen of high melting-point was prepared, possessing properties similar to those of commercial mineral rubber, of the type manufactured in tne United States from South American natural asphalts.

The influence of variations in time, temperature and rate of aspiration on the properties of the bitumen was investigated. It was found that for a given period of blowing, a higher rate of aspiration yielded a product of higher melting-point, provided the temperature was maintained constant. Certain catalysts were found to decrease the time and rate of blowing necessary to produce a mineral rubber.

Vulcanization tests of rubber containing 5 and 10% of the product in comparison with a commercial mineral rubber indicated that rubber products containing mineral rubber prepared from Alberta bitumen are on the whole superior in tensile strength. Investigations on the use of blown bitumen products in paints are under way, and apparatus has been assembled for the treatment of relatively larger batches of bitumen to supply rubber manufacturers with mineral rubber for trial.

Synthetic Resins

C. Y. Hopkins

Work has been continued on the synthetic resin described in the last report. The two steps required for its preparation have been standardized and the possibility of using it in the manufacture of laminated glass has been materially advanced.

In this connection, studies were made of the effect of varying degrees of polymerization and of varying amounts of plasticizer. A number of tests for determining the resistance to shattering have been investigated and carried out.

As a result of the experiments, samples of laminated glass of good quality have been made, whose properties are such as to offer certain advantages over the safety glass now in use, particularly in that exposure to light does not cause discoloration.

Chemical Investigation of Plants

R. H. F. Manske

Very little has hitherto been done in the way of subjecting native Canadian plants to a thoroughgoing chemical examination. A program of work which should to some extent make good this lack of knowledge has been initiated in the National Research Laboratories. Attention is being directed largely to weeds which are poisonous to livestock and other plants of pharmacological interest.

Senecio species. This investigation, which was begun last year, had as its object the isolation and examination of the alkaloids of *Senecio spp.* (ragwort). *S. jacobaea*, of maritime origin, was first investigated, and the alkaloid jacobine was obtained in small quantities. It was soon recognized that sufficient material for chemical study would be difficult to obtain from this source and therefore attention was directed to other species. *S. vulgaris* also yielded a base which was obtained in pure condition, but the plant has been difficult to obtain in quantity. At this time there was obtained from South

Africa a shipment of *S. retrorsus* which was extraordinarily rich in a new alkaloid, retrorsine, and examination soon showed that it was closely related to jacobine. Hydrolysis of either base with alkali yielded the same basic fragment, retronecine, together with an acidic fragment, the properties of which depended upon the source. Retronecine $C_8H_{13}O_2N$, is a monacidic tertiary base, one oxygen of which is present as hydroxyl (benzoyl derivative) and the other may be present in a ketonic group. A first paper on the *Senecio* alkaloids has been published in the Canadian Journal of Research.

Indols. The investigation of the alkaloid calycanthine, $C_{22}H_{28}N_4$, has disclosed that it is a derivative of indol, and by mild degradation it has been possible to obtain N-methyltryptamine, the constitution of which was established by synthesis. A paper on the methyltryptamines and some derivatives has been published in the Canadian Journal of Research.

Following this work the synthesis of some closely related indol bases was carried out and placed on record in the Canadian Journal of Research.

Dicentra species. Previous work elsewhere on *D. cucullaria* (two publications) has not only been incomplete, but also contradictory, and since the tubers are known to be toxic, further examination was undertaken. Briefly summarized, it may be pointed out that in addition to protopine, which was already known to be present, there is contained in the tubers of Quebec origin a new base, $C_{20}H_{17}O_6N$, and a minute amount of cryptopine, which until the present had been found only in opium. The new base shows some similarity to the alkaloid hydrastine, but does not contain methoxyl groups (Zeisel).

D. canadensis, also of Quebec origin, has yielded in addition to protopine, which was already known to be present, three aporphine alkaloids, namely, bulbocapnine, corydine and isocorydine. These bases had previously been found only in *Corydolis spp.* and their occurrence in Dicentra is of some botanical interest. Furthermore, *D. canadensis* is the only plant known which contains isocorydine in appreciable quantity. Finally, an intense orange coloring matter has been obtained in a pure state.

Miscellaneous

1. *Binder twine.* At the request of the Dominion Fire Commissioner, binder twine, which is impregnated with oil, was studied from the point of view of its liability to undergo spontaneous ignition. It was concluded that binder twine has little or no tendency to suffer spontaneous combustion. (C. W. Davis.)

2. *Dehydration.* By employing an apparatus previously developed for use in an investigation of magnesian carbonates, the loss of successive fractions of water and decomposition products on heating a number of substances was studied. The substances in question were hydroxides and hydrated sulphates of calcium and magnesium, soapstone, certain samples of Canadian bituminous coals and a series of asbestos samples of various types. (A. F. Gill.)

3. *Oak casks.* Experiments were made on charred oak whiskey casks for the purpose of making recommendations as to the utilization of such casks. (L. Marion.)

4. *Glucoside from milkweed.* A crystalline glucoside was extracted from the seeds of the common milkweed. The product, which had no effect on Fehling's solution but reduced it very strongly after hydrolysis, gave a crystalline picrate and, on oxidation with alkaline permanganate, a crystalline acid. It is being examined further. (L. Marion.)

5. *Corrosion of aluminium.* An examination of the corrosion of certain aircraft gasoline tanks made of aluminium indicated that the cause of the corrosion was failure to wash out completely the flux used in soldering the joints. Another question concerning the corrosion of aluminium referred to the pistons used in certain gasoline meters.

6. *Analyses.* Among the analyses carried out during the year may be mentioned analyses of aviation gasoline, dynamite, antifreeze, fire extinguishing fluid, soaps, limestone and paints. (C. W. Davis.)

7. *Hops.* A number of samples of Empire hops were examined, with the kind co-operation of one of the breweries. An interesting point which this examination disclosed was that, although chemical analysis is incapable of evaluating hops for dry hopping, where aroma is so important, it would appear to be of distinct value in buying hops for use in the wort kettles. Certain samples examined, while rather poor in regard to aroma, were found to be exceptionally high in the bitter resin which contributes bitterness and preservative principles to the beer during boiling of the wort in the kettles. (C. W. Davis.)

8. *Cleaning public statues.* Some consideration was given to the question of cleaning statues, on Parliament Hill and elsewhere, which had an unpleasant appearance owing to corrosion of a streaky green character. After various trials it was concluded that the safest agent for removing corrosion was liquid ammonia, the original color being restored after the cleaning by judicious application of sodium sulphide solution. Although not quite as rapid in its cleaning action as acid, ammonia is to be regarded as much safer, both in regard to the avoidance of serious attack on the metal and obviating subsequent corrosion as a result of the presence of residual chemicals. The methods of removing corrosion from bronze which are commonly practiced in museums, and in which the objects, usually quite small, are immersed in very mild agents for a number of hours, were not found to be applicable to the cleaning of public statues. (C. W. Davis.)

9. A considerable number of miscellaneous enquiries from Canadian industries have been dealt with, some of them involving experimental work. As examples of such matters the following may be mentioned: *(a)* corrosion of piston rings in hot water meters, *(b)* laboratory examination of samples of varnished printed cardboard, *(c)* rubber compound for wringer rolls, *(d)* utilization of distillers' grains, *(e)* use of surplus distillery plant, *(f)* effect of iron and steel in leather, *(g)* a corrosion problem in a tannery, *(h)* examination of fireproofed canvas and wood, *(i)* preparation of asparagine, *(j)* dry cleaning of fur, *(k)* examination of silk, rayon, corduroy and other textiles, *(l)* chemical studies to assist in the development of a solder for aluminium, *(m)* a question relative to gas metering, *(n)* choice of a diluent for road tar, and *(o)* analysis of St. Lawrence River water for salt in order to ascertain the extent of diffusion of sea water up the river.

DIVISION OF PHYSICS AND ENGINEERING

R. W. Boyle, *Director*

J. H. Parkin, *Assistant Director*

In the year 1931-32 a number of experimental investigations were completed which had been commenced in the previous year. The remaining problems are being continued, and new problems have been undertaken.

On account of the financial depression the division has been obliged to forego the commencement of testing and research in the field of acoustics and sound insulation, and also in medical radiology, even though a number of requests for such work have been received from industries and professional institutions.

The wisdom of equipping the National Research Laboratories for aeronautical research and testing has already been indicated. Although construction of these laboratories was only recently finished, and as yet they are not completely equipped or in full operation, a number of urgent investigations and tests have been undertaken; others await completion of the equipment. While these laboratories were set up primarily for aeronautical work, the equipment has already demonstrated its usefulness for other purposes. It is significant that a large proportion of the work already done, in progress, and awaiting, is non-aeronautical in character.

Completion of the aeronautical laboratories will not only provide the government with a much needed source of information for use in the control of aviation and the operation of service aircraft, and the industry with facilities indispensable to the development of national aviation, but will provide laboratories generally useful in many fields of engineering.

As a part of the government's reorganization of the Department of the Interior the Cliff Street Physical Testing Laboratory of that department was transferred at the beginning of the year to the National Research Council, and the direction of the laboratory was assigned by the Council to the Division of Physics and Engineering.

In the latter part of the year under review the government instructed the Council to establish a fire-hazard testing laboratory for oil burners, and preparations were immediately begun by the division to that end.

During the year officers of the division have held very frequent meetings and many consultations with the Associate Committees on Aeronautical Research, Engineering Standards, Electrical Measuring Instruments, Radio, and other committees of the Council, and have continued the work of a complete revision of the definitions and regulations pertaining to electrical units and standards and to the approval of types of electric meters used in Canada for the purchase and sale of electric power.

Similar work will shortly be undertaken to lay down definitions and units for gas measurement and also regulations for the approval of types of gas meters used in Canada for the purchase and sale of gas.

Testing of Domestic Oil Burners for Fire Hazard

J. H. PARKIN

Instructions were received from the Committee of the Privy Council on Scientific and Industrial Research to make plans for the establishment of a fire-testing laboratory for Canada. As the testing of domestic oil burners for fire risk was particularly urgent, it was decided to proceed at once with this work, leaving other problems of fire hazard for future consideration.

A portion of one of the buildings on the annex property suitable for the purpose was prepared to house the oil burner testing equipment. Four domestic house-heating furnaces (two hot water and two steam boilers) of Canadian manufacture and of different capacities have been installed, complete with fuel tanks, heat dissipating equipment, flues and necessary electrical and water services. This equipment was practically ready for service at the end of the year.

Testing of Wall Boards and Other Low Temperature Thermal Insulation

C. D. NIVEN

The hot-plate apparatus which was installed last year has been in continuous use during the past winter. When tests were not being conducted for commercial enterprises, the apparatus was used to investigate the comparative merits, as thermal insulators, of bagasse and wood-fibre board. The problem was more complicated by the fact that no less than five items affected the results, namely, density, moisture content, duration of test, structure and mean temperature. The conclusion was reached that in comparing a bagasse with a wood-fibre board all these factors have to be taken into consideration. The results of this work are to be published shortly in the Canadian Journal of Research.

Electrical Standardization at Direct and Commercial Frequency Currents

A. J. GRANT

The standardization instruments and apparatus on hand and the additional apparatus purchased by the Council during the year were checked for accuracy of indication and operation.

The Council is now in a position to carry out standardization work on voltage, current, frequency, power (except small power, low power factor) in the direct current and commercial frequency ranges.

The lower ratio instrument transformers can be checked (up to 6,600 volts in potential transformers and 500 amperes in current transformers).

Additional shunts and inductances are practically necessary for standardization requirements. It is anticipated that they will be purchased next year.

Radium

G. C. LAURENCE

An improved form of ionization chamber, complete with accessory apparatus, has been built for precision gamma-ray measurements of radium. It is applicable, also, for the determination of mesothorium impurity in radium preparations, by absorption measurements. A new inter-calibration of the Canadian radium standards is to be undertaken shortly with this instrument, and it is to be used also in the routine calibration of the unknowns which are submitted to the National Research Council.

A small radium emanation purifying apparatus will be built shortly, and an investigation is contemplated with the object of attempting certain improvements in the design and in the technique of handling therapeutic emanation appliances, to permit more satisfactory gauging of dosage, and better localization of irradiation by utilization of the beta radiation and taking advantage of its high absorption coefficient.

A Standard of Radio Frequency

W. A. STEEL

Through the co-operation of the Royal Canadian Corps of Signals, Department of National Defence, a general radio standards frequency assembly was secured and set up in the laboratory. Suitable receiving sets were obtained so that the frequency could be checked against standard time signals and also against the standard frequency transmissions from Washington, D.C.

This frequency standard consists of a quartz crystal bar in a special holder, together with the necessary valve oscillating circuits. Two temperature controlled chambers are used, the inner one containing the crystal only and the outer one the oscillating circuit and one stage of amplification. Three multivibrator circuits are used, supplying frequencies of 100, 10 and 1, kilocycles respectively. A synchronous motor, driven from the 1,000-cycle circuit, operates a clock from which time signal comparisons are made.

Particular attention has been paid to constant temperature control of the crystal and this was found to involve controlling the temperature of the room to within a few degrees Fahrenheit.

When first arranged trouble was experienced in keeping the 100-cycle synchronous motor driving the clock in continuous operation and it became necessary to devise a type of ball thrust bearing in place of the jewel bearing originally employed.

The accuracy of the frequency of the crystal has at all times been better than one part per million and has been held to within three parts in ten million for periods of a month at a time.

Aeronautics

J. H. PARKIN, J. J. GREEN, G. J. KLEIN, K. F. TUPPER

Aerodynamic Laboratory

The construction of the wind tunnel was sufficiently advanced to permit a trial run at low power on May 28, 1931, and a full power run on June 9. Preliminary adjustment and calibration of the tunnel then proceeded.

Pressure of urgent research and test work has prevented fine adjustment and complete calibration of the wind tunnel, but with such adjustment as has so far been possible, the tunnel has exceeded the anticipated performance of the design in almost every respect. The maximum measured air speed (without honeycomb in place) is 150 miles per hour at 1000 propeller r.p.m. and with a power consumption of 600 horsepower, corresponding to a maximum air speed of 163 miles per hour at the permissible maximum overload capacity of the motor. These figures indicate a power factor of 0·38, which places the tunnel among the two or three most efficient wind tunnels now in operation. In ability to approach full scale conditions the Ottawa tunnel ranks fifth, and in maximum air speed possibly second.

Although adjustment of the vanes has, up to the present, been rather superficial, the velocity distribution throughout the jet is quite uniform, without the honeycomb in place, the variation from the mean over the working portion of the jet being less than plus or minus one-third of one per cent.

The automatic speed regulating system of the tunnel is now being installed and adjusted. Such trials as have been made with it indicate that the regulation of speed will be very satisfactory.

Design and construction of the aerodynamic balances have proceeded during the year. The balances are of the wire suspension type, employing knife edges, and capable of measuring lift forces up to 1000 lb., drag forces up to 250 lb., and pitching moments up to 250 ft.

Hydrodynamic Laboratory

The towing carriage was completed early in the year and, pending installation of the cables, trials were run with a model aircraft float using an improvised balance and towing the carriage manually. On completion of the cable system and the stopping portion of the automatic control gear, the first power runs were made. Since that time calibration and adjustment of the equipment have been in progress. Minor modifications have been made and certain protective devices have been added to the control system.

The speed and acceleration of the carriage are quite satisfactory. The designed maximum speed of 40 ft. per sec. is readily attained and accelerations as high as 31·2 ft. per sec. per sec. have been observed.

A towing dynamometer of the wire type, incorporating a specially designed spring balance for measuring resistance, incidence gear and lift balance has been designed, and its construction practically completed in the laboratory shops. Recording gear for the dynamometer has been designed. Calibration of the equipment and studies of the acceleration and performance are being carried on.

Aircraft Engine Laboratory

(1) *Engine laboratory.* Modification of the building to house this engine-testing equipment was completed early in the year and installation of the equipment was at once commenced. The installation of the dynamometer and accessories, including water and electric services and fan housing, was finished in November.

The equipment was tested, using a Rolls IX water-cooled aircraft engine loaned by the Department of National Defence. Standard Air Ministry type test procedure was followed in the test. The performance of the dynamometer was generally satisfactory. Certain modifications were found necessary for safety reasons and these have been made. A test with a Cirrus III aircraft engine indicated that the dynamometer cannot be used for engines of less than 100 horsepower. Tests are about to be made on a Wright J 4 B radial air-cooled engine to study further the behavior of the equipment.

The suppression of noise in connection with the laboratory is quite satisfactory.

(2) *Detonation laboratory.* The equipment for determining the knock rating of aircraft fuels was moved into a room adjacent to the dynamometer laboratory. In addition to numerous tests of samples of aircraft fuels, much attention has been devoted to a study of the technique of testing, and to the adjustment of the equipment.

A single-cylinder testing unit, with variable compression and electric dynamometer, in addition to the usual bouncing pin device, was installed in March. This unit will greatly increase the range and effectiveness of the work possible in the laboratory.

(3) *Engine museum.* The arranging of a historical museum of aircraft engines in the upper floor of the building was approved. A number of obsolete engines of historical interest, supplied by the Department of National Defence, are already in storage in the laboratories.

Hydro-electric Power Plant

The hydro-electric plant on the annex property, developing the power of the Rideau Falls, has been rehabilitated, including the replacement of the trash rack and penstock gates. The two 1000-kw. 60-cycle 2-phase generators have been reconnected to deliver 3-phase current. The change in phase was rendered necessary in order to obtain standby service from the local system and to permit the use of standard equipment.

Possession of such a plant, as a source of power for the laboratories, is advantageous in many ways, not the least of which is the saving effected in the cost of power.

Co-operation of the Department of National Defence

The very hearty co-operation of the Department of National Defence in connection with the aeronautical work is gratefully acknowledged. Advice and assistance have been freely given and equipment and personnel loaned.

Researches Completed or in Progress

Aircraft floats.
Automatic slot.
Thin flat plates.
Aircraft skis.
Locomotive design.

Tests Completed or in Progress

Capacity of roof ventilators.
Mechanical transmissions.
Windmill for aircraft.
Aircraft fuels.
Aircraft oils.

Design of Automatic Slots for Aircraft Wings

At the request of the Department of National Defence work was done on the preliminary design of an automatic or Handley Page slot for the Bellanca aircraft. A model was made, and variations in the linkages joining the auxiliary winglet to the main aerofoil were tried with a view to deducing what linkages would cause the slot to open at the correct incidence to delay the stall and augment the lift in the main wing. Further work awaits completion of the wind tunnel balances.

Aircraft Skis

For the design of trimming gear for aircraft skis the Department of National Defence required information on the aerodynamic forces on ski undercarriages. It was suggested that the forces on full-sized skis could be easily measured in the wind tunnel, and since the test speeds would cover the flying range of the aircraft concerned, the results would be directly applicable without the usual correction for scale.

Three types of ski were tested, one for the D.H. Moth aircraft, the second for the Bellanca and the third for the Fairchild 71 machine. The

work covered the measurement of pitching moment for various angles of incidence of the skis. A wide range of speeds was employed in the tests, but it was found that at any given incidence of a ski the pitching moment divided by the square of the wind speed was a constant. The mean value of this coefficient plotted against incidence gave a well-defined pitching moment curve for each ski. All moments were given in foot-pounds about the centre of the ski axle.

Locomotive Research

In recent years engineers on locomotives have been considerably troubled by having their field of view blinded by smoke from the stack blowing down over the cab windows. With the increased size of locomotives and restrictions on roof clearance, smokestacks have tended to get shorter and shorter, a fact which is partly responsible for the smoke trouble. When running at high speed the smoke usually clears the cab roof, but any attempt by the engineer to close the throttle deprives the smoke stack of the exhaust which at speed tends to make the smoke ascend, and as a result the smoke blows down in great clouds, enveloping the cab and obscuring the view of the men on the foot plate. At the request of the Canadian National Railway Company, a research has been initiated with a view to modifying the general design of the locomotive exterior to cause the smoke to assume always an ascending path, so that under all conditions the view from the cab will be unimpaired.

In conjunction with this work it is desirable that the head resistance of the locomotive be reduced by as large a percentage as possible in order that economy may be secured on fast passenger trains. An exact scale model (1″ to the foot) of a 6100-class locomotive and tender was sent to the laboratories by the Canadian National Railway Company and considerable work has been done on the problems outlined above. The scale model was suspended in the jet of the wind tunnel and by observing the amount of its sway back in winds of various speeds estimates of its resistance have been made. A drag balance of the subframe type was specially built to measure directly the resistance of the model, and in order to facilitate the study of the effects of modifications a wooden model of the locomotive and tender was made and is being used for most of the work, being more easily altered or added to than the steel model supplied by the company. Comparison of the resistances of the two models has been made and the effect of the proximity of the ground on resistance has been studied. A number of schemes for reducing resistance by streamlining or fairing are to be examined and their effect on the flow of smoke observed.

Thin Metal Plates

The theoretical considerations of the strength of uniformly loaded metal plates, for example the panels of a flying boat hull or seaplane float, are quite complex, and considerable difficulty is experienced in the practical measurement of the load carried by any particular panel. In view of the meagre amount of information available, the Department of National Defence requested tests on Alclad sheets of various sizes and thicknesses with a view to determining the maximum load that can be carried without exceeding the elastic limit, and if possible what ultimate load can be sustained.

Equipment was designed and constructed for testing panels 8″ x 8″ or 8″ x 16″ under loads up to 150 lb. per sq. in., measuring the deformation of the panels under the various loads applied. This work is still in progress.

Aircraft Floats

The Department of National Defence requested comparative model tests on floats of three types, constructed for the same aircraft, to supplement full-scale test data for the same floats.

A pair of one-sixth scale floats of one type were constructed and tests on a single float have been made, towing the carriage manually and with improvised balance equipment. Work on this investigation has been suspended pending completion of the carriage driving gear and the towing dynamometer.

Cliff Street Laboratory

R. H. Field, S. J. Murphy, W. J. Linford

The Cliff Street Physical Testing Laboratory is engaged mainly in standardization and allied operations, on behalf of various branches of the government services, and for the public. There follows a brief review of its activities during the year.

Metrology

This section acquired two laboratory standard one-metre rules of 43% nickel-iron alloy, to replace the pure nickel and the 42% nickel-iron rules which had formerly served as the reference standards for the International metre. The nickel rule is the official Dominion metre prototype and is therefore used as infrequently as possible, while the old 42% rule is badly corroded on the speculum-finished graduated surface and is likely at any time to become useless.

In addition, a "Fixinvar" rule was acquired, to improve the method of building up lengths from the metre standard to the greater lengths used in surveying operations.

All three of the new rules were compared with the International Standards at Sèvres, France, in July.

On account of the reduction of staff it was not possible to find any time during the year for the maintenance of standards, and the only active length operations consisted in verifying a number of steel tapes.

No standard sieve was tested during the year, despite the fact that these tests are provided for in the C.E.S.A. specifications for Portland cement. The probable explanation is that these sieves are not manufactured in Canada, and the vendors stock them already certified by the national laboratory of the country of origin.

Hydrometers

The usual number of hydrometers was received for test, and this year it is gratifying to report that practically all of the new and reconditioned instruments submitted had errors within the tolerances.

Aircraft and Allied Instruments

A considerable number of aircraft instruments passed through the laboratory. The test equipment has been kept up-to-date, and compares favorably with that in other national laboratories. In view of the increased

importance of turn indicators, dependent on gyrostats, a variable speed turntable was constructed to permit standard tests being made of these instruments. Preparations were also made to construct a vibration board, with adjustable frequency and amplitude, to permit the application of vibration tests to aircraft instruments.

Two limited scale altigraphs were constructed for registering the heights of aeroplanes engaged in photography. A field trial on these instruments gave promising results and it is proposed to continue their development.

A meeting of the Aeronautical Section of the Engineering Institute of Canada was held at the laboratory on November 13, 1931, when a paper was presented on "Aircraft Instruments," and the equipment of this section was placed on exhibition for the benefit of the visitors.

In the spring the regular annual class of pilots and camera operators of the Royal Canadian Air Force attended the laboratory for instruction in the calibration and characteristics of aircraft instruments and aerial cameras.

Thermometry

There was some falling off in the number of thermometers submitted for verification, probably due to the depressed condition of industry. A remarkable difference was noted in two consignments of clinical thermometers by different makers, received for test about the same time. In the consignment "A" of British manufacture comprising 1,440 thermometers, 11, or 0·8%, were rejected for failure to comply with the laboratory tolerances, while in consignment "B" comprising 300 thermometers submitted to identically the same test program, 50, or 16·7%, failed to pass the test.

The laboratory standard thermometers were checked from time to time, to ensure that the standard scale of temperature was being properly maintained.

Preparations were made to construct a fused salt bath for comparing thermometers at temperatures above 300° C.

Optical Instruments

The number of instruments dealt with was considerably below the average of the past few years, mainly due to the large curtailment in government survey operations.

Some work was done on the development of laboratory methods for determining the distance and position of the principal point in aerial survey cameras.

General

As in the past, advice and assistance was rendered from time to time to officers using various scientific instruments.

Among instruments designed, and constructed in the shop, were a special angle-measuring instrument for the artillery service and a parallax-measuring stereoscope for the geographical service, Department of National Defence.

List of Tests Made, 1931-1932

Description	Government	Commercial	Total
Metrology			
Tapes:			
300-ft. steel tapes	11	—	11
100-ft. steel tapes	22	3	25
50-ft. steel tapes	—	1	1
30-ft. steel tapes	—	1	1
Hydrometers:			
Petroleometers	280	—	280
Sike's hydrometers	159	—	159
Keen's wine hydrometers	22	—	22
Saccharometers	3	—	3
Watches and chronometers:			
Stop watches	7	—	7
Aircraft clocks	5	—	5
Aircraft and Allied Instruments			
Altimeters	105	35	140
Altigraphs	2	—	2
Airspeed indicators	87	33	120
Tachometers	105	2	107
Compasses	55	—	55
Bank and turn indicators	37	6	43
Rate-of-climb indicators	25	1	26
Fuel pressure gauges	10	—	10
Oil pressure gauges	36	—	36
Boost gauges	4	—	4
Fuel flow meter	—	1	1
Volt and ammeters	6	—	6
Aneroid barometers	64	—	64
Hydrographs	5	—	5
Thermometry			
Mercury and spirit thermometers, below 100° C.	211	7	218
Mercury thermometers, above 100° C.	225	—	225
Clinical thermometers	1,845	—	1,845
Mercury dial thermometers	23	1	24
Thermograph	—	1	1
Thermostats	2	—	2
Thermocouple dial thermometers	2	—	2
Sterilization temperature indicators	—	12	12
Optical Instruments			
Transits	56	—	56
Levels	6	—	6
Telescopic alidades	11	—	11
Prismatic astrolabe	2	—	2
Aerial cameras	35	—	35
Photographic shutter speed determinations	198	—	198
Telescope definition tests	4	—	4

Electrical Engineering

B. G. Ballard

New Building

The progress of all work in the new building was followed very closely. Decisions as to the detailed arrangements of many of the services, such as water, waste, air, steam, electrical outlets, etc., were taken and the installation of these items supervised. The installation is now practically complete.

In a number of cases small changes were made in order to provide more adequate service. The lighting of the laboratories was studied and provision made for a light intensity of at least 15 foot-candles on all bench surfaces.

A complete study of telephone service was undertaken and a final arrangement of telephones has been approved.

Following the decision to purchase power at 11,000 volts instead of 550 volts, the power requirements of the building were studied anew and provision made for an ultimate load of 2,000 kva. at 550 volts. At the present time only two transformers are being installed, which will limit the capacity to approximately 1150 kva. This will be adequate capacity for some time to come. The transformers have been purchased and installed.

In order to provide direct-current service for the building, a 100 kilowatt 3 wire, 120-240 volt, motor-generator set was purchased, which is also installed and available for use.

Owing to the prevalence of 25-cycle per second alternating current supply circuits in the country, particularly in Ontario, a synchronous motor-generator was purchased to provide 25-cycle power. By means of transformers it will be possible to secure this service at voltages up to 2200, at one, two or three phase.

A battery system has been purchased and the installation is now practically complete. Two sets of batteries have been acquired, one for voltages up to 120 with a capacity of 160 ampere hours, the other for voltages up to 240 with a capacity of 240 ampere hours. The cells are arranged in groups of three so that any voltage in multiples of six up to the limit of the total battery voltage may be secured and distributed as required. Owing to the wide variety of loading to which individual groups will be subjected these groups are charged in parallel on 7·5-volt bus-bars in such a manner that each group is charged at a rate dependent on its state of discharge.

Electrical Systems for the Aeronautical Laboratories

The wind tunnel of the aeronautical laboratories has been completed and the electrical equipment has been in service for some months. Considerable time was devoted to the preliminary adjustments with the result that the operation of this electrical equipment is proving satisfactory.

An electrical system was installed for the engine test laboratory which included a 275 horsepower, wound rotor, induction motor arranged with speed control to provide cooling for the engines under test. This motor installation necessitated a transformer bank, which was installed outside the building. Starting equipment for the internal combustion engines was installed. This equipment has been in satisfactory operation for a number of months.

Oil-burner Testing Laboratory

The electrical requirements of the proposed oil-burner testing laboratory were studied and specifications for the work to be done were prepared. The contract for this work was placed and the installation is now completed. It provides adequate lighting and power service for operating the oil-burner equipment at either 110 or 200 volts a.c., and also provides service for the equipment dissipating the heat generated by the furnaces.

A New Type Electrostatic Voltmeter

G. S. FIELD

For the measurement of voltages up to 100,000, an electrostatic voltmeter was designed which appears to have several advantages over other existing meters. Several rough models were made for experimentation, and the final instrument is now being constructed in the workshop.

Meter Approvals

A. J. GRANT

The Electricity Inspection Act requires that all meters and apparatus used to measure electricity for the purpose of making a charge must be of a type that has been approved by the National Research Council. The Order-in-Council of September 12, 1929, requires the National Research Council to publish the tests by which the apparatus will be judged. The regulations governing watt-hour and ampere-hour meters are practically completed and will be submitted to the Council in the very near future. The regulations for block interval demand meters are also nearly completed. They will be submitted to the Council during the summer of 1932.

Regulations covering instantaneous graphic demand meters and instrument transformers will be submitted to the Council next year.

Pending publication of the Council's regulations, all meters submitted to the Council for approval have been tested on the basis of the regulations of the Gas and Electricity Inspection Service.

The Heat Conductivity of Refractories

C. D. NIVEN

At the request of the Mines Branch, Department of Mines, an apparatus has been designed and constructed to measure the thermal conductivity of insulating diatomite bricks. The hot plate is designed to stand a temperature of 1200° F. The heating element consists of two chromel spirals wound in grooves cut in two alundum disks. The apparatus is still in the experimental stage, but is being tested continually.

Vibrations in Transmission Lines

C. D. NIVEN

The work which had been begun last year has been continued. The fact that an ice coating failed to facilitate resonance suggested that the vibrations considered were caused either by lateral swinging of spans or by wind, the action of which had not been fully understood. Various experiments were arranged and carried out, with the conclusion that a wind which was not steady but pulsating was required to start large vibrations. The results of the work are to be published this year; but as the research indicated the necessity of observations on actual lines with meteorological apparatus at different stations, further investigation here will be discontinued.

The Construction of Artificial Lighting Units Suitable for Grading Grain

D. C. Rose

Continuing this work from the previous year, two lighting units were sent to Winnipeg and installed in the inspection room of the Board of Grain Commissioners. One unit consisted of three lights of different colors of the discharge tube type in which an attempt was made not to imitate daylight but to emphasize the good and bad points of wheat. The second unit consisted of daylight lamps so arranged as to give proper diffusion and eliminate glare.

A trial with these lights indicated that the daylight lamps gave 90% accuracy and the colored lights 88%, using north skylight grading as a standard and with no particular training of the inspector with artificial light.

An examination of the normal daylight lighting of the inspection benches in the inspection room in Winnipeg indicated that the intensity on clear bright days changes by as much as 50% of the mean value. This is also accompanied by change in color.

On the whole the results of tests indicated that artificial light could be used to grade grain as well as natural light, and if proper attention is given to the decoration of the grading room, the position of the grading tables, hours of work, etc., personal discomfort should be eliminated and uniform grading in so far as it is possible should be obtained at different times of day as well as in different localities.

The lighting units were left at Winnipeg for prolonged trial.

The Elimination of Static Electricity in the Fairchild Aerial Camera

D. C. Rose

The problem of the elimination of static markings in aerial camera films has been carried over from the previous year.

For static eliminating devices, special rollers, and the introduction of radium into the camera to discharge the film without a spark, were tried. These have not been given sufficient field tests to make it possible to report on the results. Other static eliminators built by the Fairchild Camera Corporation along the lines suggested in a preliminary report on the subject, issued by the National Research Council, have been used more extensively during the summer of 1931 by the Department of National Defence. An analysis of their report shows that about 50% of the trouble was eliminated. The report also indicates that trouble due to static throughout the past season was less than usual.

Further experiments are being performed in the laboratory to find the exact conditions under which static markings are most likely to occur. A cylindrical iron tank has been built in which pieces of film can be rubbed with felt, etc., as in the camera, the charge on the film being measured directly. The pressure, temperature and humidity in the tank can be controlled. The results are still incomplete but indicate that changes in pressure or temperature are liable to cause marked increases in the quantity of static charge generated.

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Electrical Properties of the Atmosphere in the Neighborhood of Flying Aircraft

D. C. Rose

In connection with the elimination of static markings on the films of aerial cameras, measurements of the electric charge in the atmosphere were taken from flying aircraft. The measurements indicated a marked stratification of the atmospheric space charge at and just above the cloud level. Even on cloudless days the cloud level was clearly indicated by the point of maximum relative humidity. At the cloud level the excess of positive space charge over negative shows a definite maximum with a corresponding minimum 4,000 to 6,000 ft. farther up. In the measurements taken only the lighter charged particles (small ions) were measured.

Plans and equipment are being prepared to carry these experiments further, attention being given to the following problems:

1. The relation between the electrical stratification mentioned above and cloud formation.

2. The settling of some controversial points in the growth of the electrical charges in cumulus clouds of the type which develop into thunderstorms.

3. The possibility of using atmospheric electrical phenomena and the charging of an aeroplane during flight as an aid to the estimate of altitude in blind flying.

X-ray Crystallography

L. E. Howlett, G. C. Laurence

X-ray spectrographic equipment has been set up and some routine crystallographic testing has been carried out.

X-rays

G. C. Laurence

An X-ray ionization chamber of the portable type designed by Dr. Taylor of the Bureau of Standards with the necessary additional apparatus, has been built for precision measurement of X-ray intensities and the calibration of X-ray equipment.

Temperature Standardization Equipment

C. D. Niven

Owing to the absorption of the Physical Testing Laboratory of the Topographical Survey by the Division of Physics and Engineering, a number of the original plans for temperature standardization had to be altered. For low temperature work, all that was required to bring the equipment up to date, was a Mueller bridge with galvanometer, a sulphur boiling-point apparatus and platinum thermometers. This equipment is being installed. In order to standardize higher temperatures in the thermal scale, designs have been completed for a molten salt comparator and thermocouple standardization equipment.

Preparation of Optical Laboratories

L. E. HOWLETT

The work in optics was initiated in the autumn of 1931. The foundations have been laid for research and standardization in a number of branches of this broad field.

Lamp Standards

Steps have been taken to preserve the international candle. The Bureau of Standards, Washington, and the National Physical Laboratory, Teddington, England, have kindly undertaken to supply this laboratory free of charge, with sets of lamp standards similar to their own "primary" standards.

Apparatus for the calibration of lamps is being provided. A precision optical bench is available for horizontal intensity work. A 60-inch integrating sphere is being constructed and will be finished in the very near future, Consequently this laboratory is prepared to calibrate submitted lamps or supply sub-standards to those desiring such. These lamps can be standardized according to any of the usual procedures, *i.e.*, candles or lumens, at a given voltage, amperage, or efficiency.

Optical Pyrometers, Color Temperature and Black Body Radiation

A source of black body radiation is under consideration. This is primarily for the calibration of a precision optical pyrometer which is to be installed. It will also serve to calibrate optical pyrometers submitted to the laboratory for that purpose and serve as a standard for color temperature. The importance of the latter function is already indicated by inquiries received.

Transmission and Reflection Measurements

A visual spectrophotometer has been secured. The laboratory is therefore prepared to carry out transmission measurements on transparent substances. Auxiliary apparatus is at present being constructed to permit of reflection measurements being done under diffuse conditions. Manufacturers' requests have indicated that this sort of work must be extended to the ultraviolet. Steps are being taken to that end.

Indices of Refraction, Lens Testing, etc.

It is evident that the laboratory will be called upon to make tests on camera lenses. Consideration is therefore being given to such installation as is necessary for this work. It is also hoped to provide facilities for precision measurements on indices of refraction, prisms and in other branches of geometrical optics. The work on lens testing will be of service to projects of aerial surveying and mapping, as in this type of work it is essential for high precision to know the corrections necessary due to lens distortion.

Spectroscopy

Medium power spectrographs are available for work in spectroscopy. They are especially suitable for such work of this nature as occurs in mineralogy and allied sciences.

Colorimetry

The specification of color can be undertaken on the basis of the tri-color scheme according to the specifications commonly used on this continent. (Report of the Committee on Colorimetry T.O.S.A., 1922.)

The Measurement of the Velocity of Ultra-high-speed Rifle Bullets and Their Effect on Armor Plate

D. C. Rose

This investigation has been undertaken at the request of the Department of National Defence and with their co-operation.

The problem arises from the performance claims of manufacturers of a new type of rifle and ammunition which produces higher velocities of the projectiles than have been previously obtained.

Plans and instruments are being prepared for a short rifle range in the sub-basement of the new building. New methods of measuring the velocities are to be tried.

Precision Capacity Measurements

W. A. Steel

In order to provide for the many precision capacity measurements required in the laboratories, and to be in a position to calibrate such condensers as are sent in from outside laboratories and from manufacturers, a Carey-Foster capacity bridge was obtained and set up permanently for high precision work. Capacities from 10 micro-microfarads to one microfarad can now be measured with an accuracy of better than 0·1%.

Atmospherics

W. A. Steel

As the result of conferences between the National Research Council and the Radio Research Board in England at the time of the Imperial Economic Conference in 1930, Canada undertook to co-operate with England in connection with the study of atmospheric disturbances. The Radio Research Board had developed special apparatus for this work and an order was placed with the Board for one complete set of equipment to be made in their workshops at Slough. This apparatus consists of two distinct parts, an atmospheric recorder and a cathode ray direction finder for atmospherics. These two pieces of equipment have been set up and tested prior to being moved into the new building. A short description of each piece of apparatus follows:

Atmospheric Recorder

A pair of loop aerials set at right angles is rotated continuously by means of a clockwork motor. This motor also drives a recording drum carrying a sheet of paper. The signal received in the loops from the static discharge is amplified and rectified and passed to an oscillograph mechanism operating a recording pen. The apparatus is so constructed that it responds only over a very narrow sector centered on the azimuth of the source, and in addition indicates the sense of that source.

Cathode Ray Direction Finder

Two large loop aerials set at right angles to one another are connected through superheterodyne type receivers and amplifiers to the two pairs of deflection plates of a Von Ardenne type cathode ray oscillograph tube. Beat

frequency and testing oscillators are provided and the two channels are each equipped with phase control devices. A camera with a continuously moving film is used to record the direction of each incoming static discharge. The angle of the deflection of the spot, under the influence of a discharge, will bear a definite relation to the angle of the incoming electromagnetic wave. When calibrated, the direction and intensity of the disturbance can be read directly from the record on the film.

Radio Measurements During the Total Eclipse, August, 1932

W. A. STEEL

The Radio Research Committee, at a general meeting held on January 6, 1932, decided to undertake measurements on the height of the Heaviside layer and on signal fading during the time of the total eclipse of the sun in August of this year. McGill University and the National Research Council will carry out the Heaviside layer work while the Northern Electric Company and the Canadian Marconi Company will undertake the fading measurements.

For the ionized layer work a small transmitter, keyed by a synchronous commutator, will be used to send out very short pulses of about 10^{-4} seconds duration. Frequencies in the 3,000-kilocycle band will be used. The receiving apparatus will consist of a short-wave converter and a broadcast receiver chassis feeding a Von Ardenne cathode ray oscillograph. A 1,000-cycle valve oscillator will supply the necessary time markings.

The fading measurements will be made by an actual measurement of the field strength of the received signals. It is proposed to take measurements in the short-wave and broadcast bands.

A New Sweep Circuit Device for the Cathode Ray Oscillograph

G. S. FIELD

In connection with the low-voltage oscillograph tubes, such as the Von Ardenne type, it is customary to employ what is known as a "sweep circuit," in order to obtain a steady image on the oscillograph screen of the phenomenon under investigation. Since the circuit ordinarily used will function only at comparatively low frequencies, a new circuit was developed for investigating higher frequency alternating currents and voltages.

Transmission of an Ultrasonic Beam Through Air

G. S. FIELD

To investigate the possibility of air being used as a medium for the transmission of an ultrasonic beam, the requisite apparatus was constructed and several experiments were tried. It was found, however, that none of the signals transmitted could be picked up by the detecting apparatus. Although the transmitter and receiver were of exactly the same type as had been used successfully for transmission through water, it was evident that for use in air the ultrasonic apparatus would have to be completely redesigned.

Vibrations in Cylindrical Rods

G. S. FIELD

This is a continuation of the work begun last year and described under the heading "Velocity of Sound in Cylindrical Rods". Several methods of attacking the problem have been investigated. By one method, measurements of sound velocity were made up to a frequency where additional complexities prevented further observations being made. Another experiment was devised which at first seemed promising, but it, too, had to be discarded. A third experiment is now being tried, and preliminary work which has been done suggests that this method will yield very valuable information on the vibrations that occur in solid rods. Application of these results will be made to the mechanical vibrations possible in radio frequency standardization apparatus.

Velocity of Sound in Liquids Contained in Cylindrical Tubes

G. S. FIELD

The work carried on during the preceding year has been supplemented by several experiments. It has been shown that at certain frequencies sound travelling along a tube of liquid may be completely absorbed. At these frequencies the energy which was originally travelling along the tube goes into a radial vibration, and is thus completely wasted as far as longitudinal transmission of the sound is concerned. The frequencies at which such absorption occurs may be calculated from theoretical formulas which have been developed.

Raman Effect

L. E. HOWLETT

Some theoretical work has been done on the relative intensities of Raman tints arising from different incident frequencies. Experimental work is now in progress to verify the conclusions.

Soft X-ray Excitation of the Photo-electric Effect in Metals

G. C. LAURENCE

This work, which was commenced last year, had to be dropped temporarily for lack of facilities in the present laboratory quarters, but is to be resumed shortly in the new laboratory building.

Moisture Precipitation on Dust and Ions

G. C. LAURENCE

This work is being continued and a technical account of it will shortly appear in the Canadian Journal of Research.

Instrument and Model Shops

J. H. PARKIN

The instrument and model shops have been in full operation during the year. The volume of work has increased to such an extent that the shops are unable to cope with it. Additional machine tools were installed and the shops are now reasonably well equipped, but are seriously understaffed.

The work of the shops includes the construction, modification and repair of instruments, apparatus, furniture and equipment, construction of models, and the installation of machines and equipment.

During the year the management of the shops was placed under a committee operating under the chairmanship of the President. Direct control of shop operations is effected by the committee through the assistant director of the division, who is also vice-chairman of the committee. This system of control is functioning satisfactorily.

DIVISION OF RESEARCH INFORMATION

F. E. LATHE, *Director*

The Division of Research Information is one of the four professional divisions in which the work of the National Research Council has been organized. To it is assigned responsibility for the collection and distribution of information on scientific and technical subjects, principally for the Council's own laboratory staff but also for those working with financial assistance from the Council in outside laboratories and for independent research workers throughout Canada. In fulfilment of this purpose the work of the division has been organized in the following main branches:—

(1) National Research Library
(2) Research Information Service
(3) Publications
(4) External Research Activities.

The collection of information is made chiefly through the National Research Library, which now subscribes to a large number of the most important research journals throughout the world. These journals, constituting as they do a permanent record of the results of scientific and industrial research, are the foundation upon which new researches must be based. Only by constantly keeping in touch with such sources of information can duplication of effort be avoided and advantage be taken of the progress made elsewhere. In addition to the journals the Council purchases for the library a moderate number of scientific and technical books.

To supplement these major sources of information special inquiries are occasionally conducted for the purpose of securing data not available in published form. Contacts are thus made with government organizations and individual research workers in various parts of the world and valuable information is secured on subjects in which the Council has a special interest.

The information thus collected is made available to the Council's laboratory staff chiefly through the facilities of the library, which are in constant use. In addition, however, four or five members of the staff of the Research Information Service spend practically their whole time in reviewing the literature, for which work they are especially fitted by language study and

thorough training in one or more branches of science. It is the duty of this staff to prepare reports for the Council on subjects on which research is contemplated in order that the present state of knowledge may be accurately determined and an intelligent decision reached as to the advisability of undertaking a laboratory investigation. Similar reports, but ordinarily of a less comprehensive character, are prepared for research workers outside the Council's staff, largely in response to inquiries received from industrial concerns in Canada.

While certain of the results of the Council's work, being of industrial importance and of interest to competitors in foreign countries, cannot be published in detail, the majority of the scientific advances made by the Council's staff are reported in the Canadian Journal of Research, which is now in its fourth year of publication and is already well established as one of the important scientific journals of the world. Certain information of interest to specific Canadian industries or agriculture is published in technical reports and bulletins, which appear at irregular intervals, but these are issued less frequently than before the establishment of a regular monthly journal. The publication of the annual report of the National Research Council is also one of the responsibilities of this division.

It is also the duty of officials of the division to perform a large amount of secretarial work for research committees of the Council, which previous to the establishment of the National Research Laboratories were responsible for the Council's major activities and which even now provide for effective contact and co-operation between the research staff of the Council, research workers elsewhere, and technical and other representatives of industry.

The staff of the division is also called upon for many miscellaneous tasks. During the last few years appreciable demands have been made on the time of the director and others in assisting the President in the preparation of plans for the National Research Laboratories, now practically complete. Assistance has been given in connection with several investigations in the Divisions of Chemistry and Physics and the director has retained charge of the magnesite investigation, which is described elsewhere in this report. Many translations of technical and scientific papers have been made for the staff of the National Research Council and others, and several statements regarding the work of the Council have been prepared for various government and other publications.

In spite of the considerable increase in the work of the division no additions have been made to the staff during the year under review.

National Research Library

Misses M. S. Gill, E. Twohey, D. Y. Willoughby

Owing to the necessity for economy the purchase of books during the year has been limited to those most urgently required. The library has added 2,551 volumes by gift and purchase and has had 619 volumes bound. The periodicals regularly received total 527, in addition to 197 government and institutional publications which appear at irregular intervals. Many of these have been obtained in exchange for the Canadian Journal of Research. Patent specifications added to the library during the year number 334, these being required not only in connection with industrial developments in the Council's laboratories but also for the great amount of technical information which they contain.

The inadequacy of the Council's present library is shown by the fact that it has had to borrow during the year from 15 Canadian and four foreign libraries. Supplementing these interlibrary loans a large number of photostat copies have been secured of articles not available on loan.

As an indication that the National Research Library is in return able to render some assistance to other libraries it may be noted that loans were made during the year to eight libraries. Books and periodicals to the number of 2,710 have been borrowed by the Council's staff, in addition to the large number of periodicals which are regularly circulated to members of the laboratory divisions.

The library again gratefully acknowledges its indebtedness to the Library of Parliament for a number of sets of scientific periodicals which are proving of great value.

During the year an arrangement has been continued whereby the National Research Council provides accommodation for the Library of the Royal Society of Canada and makes it available to its own staff. This arrangement, it is believed, is working out satisfactorily to both organizations.

Research Information Service

F. E. Lathe, S. J. Cook, A. C. Halferdahl, C. A. MacConkey, R. Ruedy, Miss M. E. Whalley

The services rendered by this branch vary widely in character. A large number of the inquiries received involve only minor questions in science and technology and are readily answered without any special study of the literature. Frequently, however, an inquiry concerns a research problem of some member of the Council's own staff or a research committee, a university worker or an industrial investigator, and involves a thorough study of the scientific and technical literature of all important countries. In such cases exhaustive studies are made involving subsequently the preparation of comprehensive reports. The largest of these reports as a rule contain extensive bibliographies.

In doing this work, however, care is taken not to encroach upon the field of consulting chemists or engineers, and many requests for routine tests and information are referred to consulting firms or to some other branch of the government service.

Further, while inquiries regarding research always receive careful attention, many of those received refer to matters upon which the Council does not attempt to prepare reports. Of such a character are requests from individuals for full information regarding the technical processes of a whole industry, or letters from students desiring information regarding historical and other events for assistance in the preparation of essays. In such cases nothing more is done than to refer inquirers to sources of general information such as technical books and encyclopaedias.

The following is a partial list of those subjects upon which reports have been prepared during the past year by members of this branch, in addition to a great number of minor inquiries dealt with by letter only. These reports varied in length from two to 369 typewritten pages, with an average of 29.

Alternating Current Supply and Tariffs with Particular Reference to Power Factor, by R. Ruedy.

Aluminium Solders, by R. Ruedy.

Bark, by A. C. Halferdahl.
The Bending of Hickory, by R. Ruedy.
Bibliography on Alcohol as a Power Fuel, by A. C. Halferdahl.
Brief Survey on Weather Cycles, by R. Ruedy.
Chronic Progressive Pneumonia in Sheep, by M. E. Whalley.
The Decay of Bark and Its Use as a Fertilizer, by A. C. Halferdahl.
Diacetyl and Acetonyl Acetone and Their Uses, by C. A. MacConkey.
Di- and Tri-chlorethylene, their Fire and Health Hazards and Uses, by C. A. MacConkey.
Discoloration of Gasoline, by R. Ruedy.
Drying of Oleo-resins (Canada Balsam) and Uses in Connection with Transparent Cloth, by R. Ruedy.
Earthquake-proof Construction, by R. Ruedy.
The Electrolytic Manufacture of Chlorates, by C. A. MacConkey.
Fumigation of Grain with Hydrocyanic Acid and Other Chemicals, by R. Ruedy.
Labrador Tea, by C. A. MacConkey.
Manufacture of Tartaric Acid, by R. Ruedy.
Patents on the Manufacture of Pectin, by M. E. Whalley.
Physical Constants of Saturated Hydrocarbons, by R. Ruedy.
Processes other than the Channel Process for the Manufacture of Carbon Black, by C. A. MacConkey.
Radio Interference Caused by the Normal Operation of High Tension Lines, by R. Ruedy.
Recent Work on Silver and Its Uses, by R. Ruedy.
Recovery of Benzene and Similar Vapors, by R. Ruedy.
Refrigeration by Absorption, by A. C. Halferdahl.
Review of Literature on Magnesite 1926-1930, by A. C. Halferdahl.
Silica Gel and Active Silica, by A. C. Halferdahl.
Spontaneous Heating of Oils and Oiled Materials, by R. Ruedy.
Sumac as a Tanning Material, by M. E. Whalley.
Summary of the Recent Literature on B.C.G., by M. E. Whalley.
Thermal Expansion of Refractories, by R. Ruedy.
Use of Crude Glycerine and Calcium Chloride Solutions as Antifreeze, by C. A. MacConkey.
The Use of Iodine as a Preventive of Goitre, by M. E. Whalley.
Use of Metallic Lithium and Salts of Lithium, by R. Ruedy.
Utilization of Waste Leather, by C. A. MacConkey.
Vapor Pressure of Dissolved Benzene in Absorbent Oils, by R. Ruedy.

During the year under review translations have been made of scientific articles in the following languages: French, German, Italian, Spanish, Dutch, Norwegian, Finnish and Hungarian.

Publications

W. W. Thomson, Miss D. DesBarres

The publications of the National Research Council issued during the year include twelve issues of the monthly Canadian Journal of Research, comprising a total of 1,367 pages, and an annual report of 210 pages. Three technical reports and bulletins were in press at the end of the year under review. In addition to these the staff has done editorial work on many reports not issued in printed form.

The Canadian Journal of Research has continued to fulfil its function as a medium of publication of the work of the National Research Council whether in its own laboratories or carried out with financial assistance in the laboratories of the universities and elsewhere. The Journal is, however, open to suitable papers from any Canadian research worker. The extent to which it has been fulfilling these functions is seen in the fact that of the 109 papers published during the year 19 were written by members of the staff of the National Research Council and 67 by those working with financial assistance under scholarships or assisted researches, 22 by other Canadian research workers and one by an English biologist covering work done in Canada. Incidentally, an indication of the contribution which the National Research Council is making to scientific progress in Canada is seen in the fact that 86 papers were published during the year covering work assisted by the Council, in addition to a number of papers which, on account of their special interest to certain industries, appeared in other publications than those of the Council.

Of the 109 papers published in the Canadian Journal of Research, 46 dealt with researches in biology and agriculture, 35 with chemistry, 27 with physics and one with geology.

It is of interest to note that 60% of the subscriptions to the Canadian Journal of Research are from outside Canada, including 28 different countries in the Empire and elsewhere.

Outside Research Activities

F. E. Lathe, S. J. Cook, A. C. Halferdahl

The National Research Council has nearly 30 research and advisory committees and about 100 assisted researches under way in laboratories outside Ottawa. Members of the staff of the Division of Research Information have been assigned technical responsibilities and secretarial duties in connection with the majority of these activities, including assistance to the president of the Council in the organization of research, responsibility in seeing that the work is carried out as planned, and a study of the reports submitted. Statements regarding the activities of these committees and outlines of assisted researches are given elsewhere in this report.

SUMMARY OF ACTIVITIES OF ASSOCIATE COMMITTEES

Associate Committee on Aeronautical Research

Co-operating organization:

Department of National Defence

Two meetings of the committee were held during the year 1931. With the construction of the aeronautical research laboratories of the National Research Council the committee has been invaluable in making suggestions as to the work carried out in the laboratories, and has co-operated with the aeronautics section in every way possible. With its assistance and wider contacts the committee has been a definite aid in shaping the progress of research and tests in the aeronautical laboratories. Through the committee a liaison has been established with the Aeronautical Research Committee in England, which has resulted in an exchange of published researches. The acquisition of such publications has already proved to be a wise step and by retaining close touch with research work done elsewhere, the committee should render signal service to the laboratories.

Through the efforts of the committee an arrangement has been made with the Department of National Defence whereby officers of the Royal Canadian Air Force are sent to the aeronautical laboratories for periods of duty. In this way the Air Force personnel are receiving training in the methods employed in aeronautical research and the laboratory staff are benefiting by contact with men who are employed in operating aircraft. At present the period of duty is three months and if the plan proves successful this time will no doubt be increased.

For work on special problems connected with atmospheric electricity and radio the committee have requested the full time loan of an aircraft from the Department of National Defence. The program of work in these subjects includes:—

1. Humidity measurements.
2. Study of thunder cloud formation.
3. Investigation of the electrostatic charge on an aeroplane in flight.
4. Development of blind landing equipment.
5. Intercommunication telephone equipment for aircraft.
6. Air mail directive beacon improvements.
7. Variation of skip distance with altitude of aircraft.
8. Field strength surveys.
9. Refraction of radio waves over fresh water.

The committee advised the reservation of a floor in the engine dynamometer building for an aero engine museum. A number of old types of aero engine are in existence in Canada and a suitable place to preserve them is a matter of some importance. The Department of National Defence has already sent to the Council a number of obsolete types of engines for the commencement of an aero engine museum.

Interest is taken in aeronautical research in other laboratories in Canada, notably Toronto. In view of the lack of aeronautical training centres in Canada and the growth of interest of science and engineering graduates in the subject of aeronautics, attention is being given to the possibility of scholarships of the National Research Council being made tenable in the aeronautical laboratories.

As a result of work done on the elimination of static from the Fairchild aerial camera three reports by Dr. D. C. Rose on humidity and ionization measurements from an aircraft were received by the committee.

Associate Committee on Animal Diseases

Co-operating organizations:

Federal Department of Agriculture
Macdonald College
Oka Agricultural Institute
University of British Columbia

In order to facilitate the work of the committee, subcommittees were appointed to deal with the problems of mastitis in cattle, poultry paralysis and the agglutination test for bacillary white diarrhea of poultry. These subcommittees reported to the annual meeting of the Associate Committee held in Ottawa on March 10, 1932. As a result of their recommendations the committee has given financial support to investigations of mastitis at the Oka Agricultural Institute, and poultry paralysis at the University of British Columbia, and tentative recommendations have been prepared for the standardization of the agglutination test for bacillary white diarrhea.

The committee has also given support to an investigation of poultry parasites at Macdonald College, a report of which appears below. This work will be merged in the activities of the Institute of Parasitology in process of formation at Macdonald College with the co-operation of the Quebec government, McGill University, the Empire Marketing Board, the Federal Department of Agriculture, and the National Research Council. The Quebec government is providing the necessary buildings for the investigations and the Empire Marketing Board and the National Research Council have agreed to extend the necessary financial support for a period of at least three years.

At the annual meeting the committee discussed at some length the reproductive diseases of cattle and Dr. Savage was asked to submit definite recommendations regarding action which might be taken by the committee in this connection. It was reported that red water in cattle was being studied by the Federal Department of Agriculture and the University of British Columbia and further work on this disease was left in the hands of these organizations with an offer of the committee to co-operate in the work if desired. Osteomalacia, a deficiency disease of cattle, was also discussed but no action was taken.

Dr. Fulton reported upon his work on swamp fever of horses, which has been carried out without financial support from the committee. An effort has been made to develop a suitable vaccine. Dr. Mitchell stated that the Federal Department of Agriculture was also investigating this disease. Hypertrophic cirrhosis of the liver and sweet clover disease were given consideration but the committee did not consider that any special action was required.

There was presented to the committee a short bibliography on chronic septic pneumonia of sheep, prepared by Miss M. E. Whalley of the Division of Research Information. Dr. Fulton stated his intention to follow up his studies on this disease. Other sheep diseases discussed included infectious catarrh and fatty degeneration of the liver.

The problem of influenza in swine was regarded by the committee as of some importance and was left on the agenda for future consideration. Dr. McGillvray stated that anemia in sucking pigs could be entirely prevented by the feeding of iron in suitable form.

The committee discussed the advisability of undertaking research on various virus diseases. It was reported that little work on this subject was being carried out in Canada, although there appeared to be great need for a systematic plan of research. The committee appointed a subcommittee consisting of Dr. Tory, Dr. Harris and Dr. Klotz to give this question careful consideration and report upon it at the next meeting of the committee.

The committee also briefly discussed diseases of goats, poultry, foxes, the snowshoe rabbit and grouse, and the general question of parasites. The Division of Research Information was asked to prepare a report and bibliography on poultry paralysis.

Subcommittee on the Agglutination Test for Pullorum Disease

This subcommittee, consisting of Dr. E. A. Watson, chairman, and Drs. C. D. McGillvray, J. S. Fulton, and R. L. Conklin, reported at the annual meeting that a study had been made of the work done elsewhere and that subsequently a questionnaire had been distributed to all Canadian laboratories known to be testing poultry for this disease. Eleven laboratories had replied regarding their practice and it had been noted that three different methods of test were in use.

As a result of its deliberations, the subcommittee submitted tentative recommendations regarding the procedure to be followed in making the macroscopic tube agglutination test, which all laboratories reporting appeared to be willing to accept as a standard. Recommendations included the preparation of the antigen, the nature of the cultural method, the dilution to be used, and the interpretation of results.

The main committee, after discussing this report, referred all the questions back to the subcommittee for further study, authorized it to add to its numbers and requested it to report back at the next annual meeting.

Researches on Poultry Paralysis at Macdonald College

The work outlined in the fourteenth annual report has been continued with particular emphasis on the effect on poultry of infestation by the caecal worm *Heterakis gallinae*, on the association of this worm with "blackhead disease" and on the effect of the worm-eradicating drug, "Kamala," on the egg-laying rate and size of eggs.

Extensive and thorough studies using adequate numbers of birds have been made of the changes occurring throughout life in the food consumption, feathering, rate of growth, egg production, general condition, anatomy of the internal organs, skeleton and blood constitution, of both normal and infested birds.

The life history and development of *H. gallinae* and the type and extent of damage caused by the worms have been studied in artificially infested birds, infested both by mechanical introduction of worms into the crop, and by feeding wet mash containing worms.

As a result of these investigations it has been found that birds infested during the second week of growth show a slight check in growth by the fourth week. The infested birds also eat less than the non-infested until the end of the twelfth week. From this time on, both eat approximately the same amount per day.

Anatomical examinations confirm earlier findings in showing a definite clinical picture in infested birds. The caeca of the birds is less distended with gas and has markedly thicker walls than normal. No gross anatomical changes in the thymus such as are present in fowls infested with *ascarida*, were noted. *Heterakis*-infested birds also showed a marked reduction in the percentage of haemoglobin in the blood.

In connection with "blackhead" it was noticed that this disease became most prevalent among *heterakis*-infested birds during the third week. Marked pathological changes in the caeca of these birds were observed, consisting of great enlargement and filling with blood, followed in many cases by the production of a caseo-calcareous mass filling the entire lumen. The resultant pressure causes changes in the metabolism and circulation of the walls, leading finally to extensive fibrosis. These changes are associated with a typical blood picture, adequately described in most text books on poultry diseases.

It was apparent that *H. gallinae* was closely associated with the causal organism of blackhead, as, on recovery of birds such as those described above, re-infestation with caecal worms resulted in a further outbreak of blackhead. At the same time, the presence of blackhead in a fowl proved definitely detrimental to the growth of *H. gallinae* in the same bird. The theory that blackhead is caused by the organism known as *Histomonas meleagris*, and that this organism lives within the cells of the intestinal tract of *H. gallinae* was not confirmed. It is felt that the matter should at present be viewed with an open mind.

The factor of age was investigated and it was found that both *heterakis* and blackhead infestation were possible up to at least ten weeks after hatching.

The effect of caecectomy, or the removal of the caecum, was investigated, chloroform being found to be the most suitable anaesthetic. It was noted that extreme care was necessary to make sure that all of even the smallest blood vessels were ligated, failure in this regard leading to death from hemorrhage. It was found to be impossible to infest birds treated in this way, with *H. gallinae*.

As a result of the investigations of the drug Kamala, it was found that its administration caused a decrease in the rate of egg production and in the size of eggs of Single Comb White Leghorns and Barred Rock pullets, the effect extending over some 15 to 25 days, with the maximum effect on the ninth day.

About 25% of the birds so treated were unaffected by the drug beyond the fact that their eggs showed a decrease in weight.

(Investigation under the direction of Dr. R. L. Conklin.)

Researches on Mastitis at the Oka Agricultural Institute

During the year 283 cows on 11 new farms have been tested and cows on five additional farms have been tested a second time. The frequency of mastitis among the 283 cows, as found by biological and bacteriological tests in each separate quarter of the udder, was 36%, while the proportion in the 1222 cows tested since the beginning of the investigation was 34.2%.

The colorimetric test for pH was found the easiest diagnostic test to make, although it was not absolutely conclusive. The chlorine test is regarded as the most reliable, but a definite diagnosis requires the determination of pH, chlorine and catalase. The examination of the sediment of fresh milk is also of value.

Bacteriological studies of milk have been continued and 386 strains of streptococci have been examined. In about 20% of the cultures micrococci appeared with the streptococci, but the former were ordinarily less numerous than the latter. Extreme care was found necessary in taking samples of milk for test in order to prevent external contamination.

The streptococci found have certain characteristics which differentiate them from groups of human streptococci, and they do not have the characteristics of the usual types of pathogenic animal streptococci. It has not been demonstrated that they are pathogenic for man, although some think that they may cause disturbances in infants.

Interest in the problem of mastitis appears to be increasing. The disease is known to be very prevalent in the United States as well as in Canada.

(Investigation under the direction of Reverend Father Leopold.)

Researches on Poultry Paralysis at the University of British Columbia

Reports which have been received from poultry owners in British Columbia during the past year indicate that this disease is causing great losses. In some large flocks half of the chickens have been lost and a number of owners have been forced to dispose of their flocks. Many tests have been made for farmers and much valuable experience has thereby been gained.

A fundamental difficulty in the study of the disease is that its nature is not yet clearly understood. It is not regularly possible to transmit the disease from one bird to another and experimental work is thus greatly handicapped.

Considerable work has been done on the relation between paralysis and lymphomatous tumors. This relation appears to be closer than might be due to chance.

Some evidence has been obtained pointing to the inheritance of resistance to poultry paralysis, as indicated by differences in the proportion of paralyzed pullets in different birds and by the absence of paralysis among the progeny of certain males and in certain large families.

Published paper:

Asmundson, V. S. and Biely, J., Inheritance of Resistance to Fowl Paralysis. I. Differences in Susceptibility, Can. J. Research, 6 : 171-176. 1932.

(Investigation under the direction of Dr. H. W. Hill.)

Associate Committee on Asbestos

Co-operating organizations:

Canadian Asbestos Producers and Manufacturers
Federal Department of Mines
Quebec Bureau of Mines
Quebec Committee on Asbestos Standardization

Meetings of the committee were held in Montreal on May 23, 1931, and February 22, 1932, to receive progress reports of investigations under way by the staff of the National Research Council and to consider other matters relating to testing and research on asbestos and its products. Details of the Council's own work will be found under the report of the Division of Chemistry, p. 27.

During the year Mr. A. van Winsen was secured for work in the National Research Laboratories and in particular for the standardization of the Quebec standard testing machine. This question of standardization is regarded by the committee as of the utmost importance, since it affects the entire quantity of asbestos sold.

Dr. A. W. G. Wilson of the Mines Branch reported on his study of the failure of heating elements, said by some to have been caused by the corrosion by the asbestos insulation used. It was a question whether there had been actual corrosion or whether failure had been due to other causes. This study is still in progress.

Associate Committee of Chemists

The annual meeting of the committee was held in Montreal on May 26, 1931, immediately preceding the Dominion Convention of Chemists. There was an attendance of 19 members and persons present by invitation. New members in attendance were Messrs. K. A. Clark, F. M. G. Johnson, H. W. Matheson and E. T. Sterne.

Dr. C. Y. Hopkins of the Division of Chemistry presented a report of his work on the utilization of elevator screenings, an account of which will be found on page 32 of this report. Estimates were presented on the cost of a plant for the extraction of oil from these screenings. The committee discussed possible methods of utilizing the results of Dr. Hopkins' investigations.

A report was presented by Dr. I. R. McHaffie on the salt cake situation in Canada. The committee discussed the possibility of satisfying the greater proportion of the Dominion's requirements by the use of sodium sulphate from western Canada. It was evident that high freight charges on this material constituted a serious handicap in the large-scale development of this Canadian industry.

The question of the Alberta tar sands and their utilization was dealt with in a paper by Dr. K. A. Clark. The most promising outlet for this material appeared to be for road construction. By refining, it could be made to conform to specifications for the full range of asphalts and asphaltic oils. At present there is a small semi-commercial development utilizing the method worked out by Dr. Clark for the separation of bitumen from the sand. This method involves the treatment of the material with hot water containing a little sodium silicate or sodium carbonate to neutralize any acid present. It is believed that bitumen can be produced at a cost of one dollar per barrel. This work throws considerable light on the problem of highway construction with bitumen and various aggregates.

Abbé Vachon presented a report outlining an investigation under way on the flavoring principle of maple sugar. This study is still in its early stages but it will be continued. Dr. Whitby gave the committee an outline of the National Research Council's work on maple sugar, including both methods of concentrating flavor and the development of new products.

The uses of various grades of sodium silicate were described by Mr. E. T. Sterne. He reported that about 85% of the material sold was used in the manufacture of soap and as an adhesive in the construction of corrugated boxes.

A comprehensive report on the industrial uses of anhydrite was presented by Dr. C. A. MacConkey of the Division of Research Information. While it was apparent that anhydrite could with proper treatment be used for many purposes to which gypsum is now applied it is recognized that the latter is generally more economical.

Mr. S. J. Cook presented an interim report on certain aspects of alcohol costs, comparing various sources of raw materials. The committee were in general agreement that with gasoline at present prices it was unlikely that alcohol could be produced at a figure which would lead to its large-scale use as a motor fuel in this country.

Mr. Cook also discussed the subject of the desirability of a chemical survey of Canada. Unfortunately the Department of National Revenue is not in a position to make public all information which would be required for such a survey. After some discussion the committee decided to recommend to the Bureau of Statistics that a Directory of Chemical Industries in Canada be prepared as a first step, to be followed by a study of imports and finally a complete chemical survey if possible.

Other subjects discussed included the production of fertilizer from waste leather, fur and wool, the synthesis of methyl alcohol in Canada, the Exposition of Chemical Industries, and the distribution of surplus cereals.

Associate Committee on Coal Classification and Analysis

Co-operating organizations:

Alberta Department of Mines
Alberta Research Council
American Society for Testing Materials, Sectional Committee on the Classification of Coal
Federal Department of Mines

The committee has continued its activities throughout the year under review, both in discussions bearing directly on coal classification and in laboratory research, upon which all coal classification must ultimately be based.

An event of some importance to the coal industry throughout the world took place in November, 1931, when the Third International Conference on Bituminous Coal was held in Pittsburgh, Pa. This meeting was attended by the chairman and secretary of the main committee, the chairmen of the three subcommittees, and several other members. The opportunity was improved to have an informal meeting of the Canadian committee, and most of its members also attended meetings of the Sectional Committee on the Classification of Coal held at that time.

At the annual meeting of the American Institute of Mining and Metallurgical Engineers, held in February, 1932, one session was given over to the subject of coal classification, and there were presented papers by Stansfield and Gilbart on moisture determination for coal classification, and determination of the alkali-soluble ulmins in coal. The former paper described a method for the determination of moisture inherent in coal as distinct from extraneous moisture and also means for the rehydration to standard condition of coal which had been partly air-dried. The latter paper described a method for the determination of ulmins, found of value as a criterion in distinguishing the ranks of coals of similar ultimate analysis but different geological age.

In conjunction with the sessions of the Institute there was held a meeting of the Sectional Committee on the Classification of Coal, when matters were discussed of interest to both American and Canadian committees.

Reports of work carried out by the committee during the year were presented at a general meeting held in Montreal on April 4, 1932, at the time of the annual meeting of the Canadian Institute of Mining and Metallurgy. At this meeting the Sectional Committee on the Classification of Coal was represented by its chairman, Mr. A. C. Fieldner.

Dr. B. R. MacKay of the Geological Survey, Chairman of the Subcommittee on the Origin, Constitution, Location and Occurrence of Coal, described work being done by the Department of Mines on the coal deposits of the northeastern coast of Cape Breton Island, where a special study was being made of sulphur and its relation to the origin of the coal. This work had already proved of material value to the operating companies by indicating where mining operations should be conducted. Hundreds of thin sections and many X-ray photographs had been made of the coal, and sulphur was found to be present to the extent of about 50% as finely disseminated pyrite. The remainder of the sulphur was assumed to be held in organic combination.

A report of the Subcommittee on Sampling, Analysis and General Uses of Coal was presented by its chairman, Mr. R. E. Gilmore, of the Federal Department of Mines. The work of this subcommittee had consisted chiefly of a study of the relation of mineral matter to ash made by Mr. J. H. H. Nicolls. Mr. Nicolls had found that the factor of 1.29 was required for the conversion of ash to mineral matter in the Nova Scotia coals. The committee discussed the use of this factor and the Stansfield graphic method of determining pure coal.

Mr. Gilmore also presented a suggested new basis of coal classification worked out by Messrs. Burr and Swartzman of his staff. This method was based on the use of the specific volatile index, which, as pointed out by Prof. Stansfield, varied directly as the calorific value of the volatile matter in any coal. The committee regarded the proposed method of classification as of considerable interest and agreed that it should be given further study by the members.

Prof. Stansfield reported on the work of the Alberta Research Council carried out by himself and associates. Some of the more important results had been presented at the New York meeting. Work had also been done on the determination of ignition temperature. This subject the committee regarded as of scientific interest but not of immediate practical importance in view of the great complexity of the question. There were also discussed friability tests and methods of determination of volatile matter. It was agreed that further work should be done on the latter to determine the influence of the presence of certain minerals in the coal upon the result.

Prof. Stansfield also reported for the Subcommittee on the Applicability of the Proposed Scientific Classification Schemes to Canadian Coals. He called attention to papers on this general subject presented at the McGill Coal Symposium by Dr. E. S. Moore and himself. A second survey of Alberta coals of varying rank had been made with the co-operation of the federal and provincial departments of mines. The coal samples obtained were being tested by the Alberta Research Council. A special study of the determination of ulmins had been made. Prof. Stansfield stressed the importance of the classification of low rank coals on a moist basis, that is, as the coals existed in the mines before air-drying.

The committee agreed to recommend to the Department of Mines that microscopic work on coals be continued. It was further agreed that the committee should continue to support the work of Prof. Stansfield in co-operation with the Alberta Research Council. Matters of common interest to both the Canadian and American committees were discussed by the committee at some length. It was agreed to continue the close co-operation of the two committees in order that each might have the benefit of the results of all work being done. Arrangements were made for the Canadian committee to be represented at a meeting of the American committee to be held at Atlantic City in October, 1932.

Associate Committee on Engineering Standards

The Canadian Engineering Standards Association operates as an associate committee of the National Research Council, from which it receives a large share of its funds. Five members of the Council or its staff—Dr. H. M. Tory, Dr. R. W. Boyle, Dr. A. Frigon, Mr. F. E. Lathe and Mr. J. H. Parkin—are amongst the 55 members of the main committee. The total membership of all committees of the C.E.S.A., as at March 31, 1932, was 606.

The primary object of the committee's work is to set up standards for the guidance of Canadian industry. These standards, the observance of which is purely voluntary, are nevertheless being widely adopted by provincial and municipal governments and industrial firms throughout the Dominion. In the establishment of standards, manufacturers and consumers are called together in conference and jointly agree upon such standards as are believed to represent the best practice in the particular industry concerned. Usually the recommendations of the committee include a very great reduction in the number of sizes manufactured. By confining themselves to these sizes, manufacturers are able to reduce production costs, middlemen to reduce stocks and increase turnover, and consumers to purchase standard goods at lower prices. Many other advantages of simplified practice are compelling industrial concerns to fall into line if they are to continue to hold their place in the severe competition of the times.

Civil Engineering and Construction.

Wood Piles and Pile Driving. The collection of data on available sizes of piling timber has been continued, and in addition to co-operation from the Forest Products Laboratories a representative of the Forest Service is summarizing all the information available. It is hoped to have a comprehensive statement prepared shortly. Preparation of the specification itself has been held pending the completion of this work.

Building Materials. As referred to in the last report, a request was received from the Royal Architectural Institute of Canada that the Association consider the standardization of building materials, and a conference was held in Toronto on January 16, 1932, at which representatives of the National

Research Council, Engineering Institute of Canada, and Canadian Construction Association were present. It was hoped to have representation from the Canadian Purchasing Agents Association, but this could not be arranged. Those at the conference decided unanimously that the C.E.S.A. should undertake this work, and those present were constituted a tentative committee on building materials, the intention being to form panels for each specific material as the work progressed. In the work of these panels it is proposed to enlist the co-operation of trade associations and industrial representatives interested in the particular material. It is hoped to do valuable work on lumber, brick, tile, millwork, etc., used in the building trade. Arrangements will shortly be made for a conference on the standardization of brick sizes.

Mechanical Engineering

Screw Products. The drafts covering established lists for cap and set screws and studs, and for machine, carriage and plough bolts, are now in final page-proof form and will shortly be sent out to the committee for approval. The co-operation of the two railway companies has been secured and an endeavor has been made to cover any particular railway requirements. In connection with the latter list, it has been proposed by the railways that the list be extended to include heavy bolts and nuts used in railway service, and this is now being considered.

Bar Size Tolerances for Bolts. At the request of the Canadian National Railways, it was decided to organize a special panel to discuss size tolerances on bar used for the manufacture of bolts. This panel has been organized and has had its first meeting.

Blade Punching for Road Grading Machinery. General agreement has now been secured among the manufacturers on dimensions and size of bolts, etc., and arrangements have been made to send the draft out to the committee for letter ballot.

Electrical Work

Canadian Electrical Code. The special committee on revisions to the second edition of the code, proposed at the last meeting of the Code Committee, has now been organized and is considering a draft of code revisions which has been prepared. The work is being handled by a small committee, the intention being that their suggestions will be forwarded to the Code Committee for approval as each section of the code is completed. The revisions which were approved at the meeting of the Code Committee held in September, 1931, were published in the last number of the C.E.S.A. Bulletin and have been found very helpful to the different provincial and municipal inspection departments. In the wiring rules which were recently issued by the Standards Association of Australia, free use has been made of material from the Canadian Electrical Code, and this has been duly acknowledged in the preface. The code has now been officially adopted in all the provinces of Canada except Manitoba and Prince Edward Island.

In connection with Part II of the code, an approval specification for power-operated radio devices has been published, and it is hoped to publish shortly a pamphlet covering general requirements applicable to all electrical devices. Meetings of the Panel on Specifications (at which manufacturers' representatives were present) have been held to consider specifications for electric signs, oil burners, circuit breakers and electric clocks, and revised drafts are now being prepared for approval by the panel. Specifications for enclosed switches and for portable electric displays and incandescent-lamp signs are also under consideration and many others are projected.

With reference to Part III of the code, dealing with outside wiring rules, the work has been progressing, but difficulty is still being encountered in getting agreement. Indications are that marked progress will be made during the present year.

Power Transformers. With reference to the work of the panel on Transformer Bushings, it has been decided to postpone work on this project, as it is felt that under existing industrial conditions it would not be advisable to impose on the interested manufacturers any expense which might be incurred on account of the proposed standardization. It was therefore decided that the specification for power transformers should be proceeded with, and it is hoped to have this issued shortly.

Watthour Meters. A meeting of the committee was held at which consideration was given to proposed revisions to the draft specification for A.C. watthour meters and for demand meters. These revised drafts will now be sent out to the committee for comment. It has been decided to issue a special specification covering instrument transformers used in connection with meters, and a panel has been appointed to consider this project. Representatives of the National Research Council have been co-operating with the committee with particular reference to the question of units and regulations regarding the inspection and testing of meters.

Insulated Power Cable. The panel appointed at the first meeting of the committee has now issued a report on lead-covered, paper-insulated cable, and it is hoped to present before long a report on the other types of insulated power cable. The first report has been sent to the committee for comment.

Ferrous Metallurgy

Heavy Steel Shaft Forgings. A committee has just been organized to discuss standards for this material, and the first meeting will be held shortly.

International Co-operation

As a result of the Imperial Economic Conference held in London in 1930, Mr. C. Le Maistre, the Director of the British Standards Institution, has been sent to the different Dominions to discuss closer co-operation in Empire standards and the encouragement of Empire trade. It is expected that discussion of this question will be included in the agenda for the Imperial Conference to be held in Ottawa this year.

An invitation was received for co-operation in a conference of secretaries of the different national standardizing bodies, at Milan in June, 1932, but it has been found impossible to take part in this conference.

Sale of Publications

The sale of publications continues to be active, and there has been a noticeable demand for specifications issued by the British Standards Institution.

Industrial Support

Support from the various industries is received under the present system of sustaining memberships and there are 81 sustaining members on the list. The total amount received from industrial subscriptions in 1931 amounted to $6,900.

Associate Committee on Field Crop Diseases

(Western Section)

Co-operating organizations:

Federal Department of Agriculture
University of Alberta
University of Manitoba
University of Saskatchewan

Since the merging of the Associate Committee on Cereal Rusts with the Associate Committee on Field Crop Diseases, in April, 1931, more responsibility has devolved upon the subcommittees set up to deal with specific projects. Two of the subcommittees, on Rusts and Plant Breeding, met during the summer to consider and agree upon uniform methods of estimating and recording damage to crops by disease. A definite system was adopted for estimating rust infection, and a tentative one for estimating damage due to the foot-rotting organisms. These systems were presented to, and adopted by, the annual meeting of the full committee at Winnipeg, in April, 1932. The subcommittees on Plant Disease Surveys and Foot- and Root-rots met just previous to the annual meeting. The former gave consideration to the problem of identifying fungi isolated from diseased plants at the various laboratories. The latter considered and made recommendations on methods of inoculating plants, estimating severity of damage, and on uniformity of terminology.

The progress made to date in the co-operative researches on the production of superior rust-resistant varieties of wheat was summarized in a statement issued after the annual meeting in Winnipeg, as follows:—

"The progress being made in the development of a new variety of common wheat capable of resisting black stem rust has been under critical review by the members of the Associate Committee on Field Crop Diseases. This review has shown quite clearly that several of the new wheats under investigation not only possess a high degree of resistance but also appear to combine satisfactorily baking quality and high yielding ability. Plans have been completed to continue the study of the relative merits of these wheats on a very extensive scale and in a manner to permit full consideration of such additional diseases as the smuts and the foot-rots. These studies involve tests during the coming year at the following points in the western provinces: Morden, Killarney, Winnipeg, Brandon, Birtle, Swan River, Swift Current, Indian Head, Scott, Saskatoon, Lacombe and Edmonton. The Associate Committee on Grain Research and the baking laboratory of the Dominion cerealist will co-operate in the making of milling and baking tests on the wheats produced at these points. It is believed that a final choice as to which of these new promising varieties is most worthy of propagation may be made within the next two or three years. In the meantime the best of these will be multiplied in order that there may be as little delay as possible in making the chosen variety available for use by farmers, especially in the rust areas."

The chairman of the committee, when commenting on the progress that had been made, stated that in his judgment the Research Council could make no other contribution to the national life of Canada comparable in importance with that of organizing on a co-operative basis the scientific workers of the nation. In a country of such vast distances and limited scientific personnel, the integration of research effort was the highest essential, and the scattering of our energies the greatest folly.

Plant Disease Survey in the Prairie Provinces

The complete report on the plant disease survey for the prairie provinces, compiled by the Division of Botany of the Dominion Department of Agriculture, was tabled at the opening session of the annual meeting of the Associate Committee on Field Crop Diseases. "The data for the plant disease survey are collected very systematically in the prairie provinces. In no other part of the Dominion is there the sustained effort to record not only the fields in which a given disease is formed but also those in which the disease was not observed." In the discussions it was pointed out that this success was undoubtedly due in no small part to the influence and co-ordinating efforts of the Western Section of the Associate Committee on Field Crop Diseases.

An important phase of the plant disease survey work, especially in regard to foot-rot, is the identification of fungi isolated from the diseased plant parts. Mycological specialists are needed to undertake this identification, and it was suggested that this type of work be centered at the laboratory where such studies could be carried on with the greatest efficiency.

The damage caused by the smuts of cereals, especially bunt of wheat, was considerably less in 1931 than in 1930. The loose smut of wheat showed the same west-to-east prevalence as in 1930, but the average prevalence was greater.

Outside of Manitoba, stem rust caused very slight damage. It was heaviest in the Red River Valley, where the loss varied from 5 to 10%. Take-all was more destructive than foot-rot in the fields affected, but on account of the smaller frequency of the former it may be of less importance than the foot-rots. Browning root-rot was less prevalent than usual, especially in the drought areas. A number of diseases not previously recognized in the prairie provinces were reported this year, but none of them were sufficiently prevalent as yet to be considered of primary economic importance.

Research at the Dominion Rust Laboratory, Winnipeg

The work at this laboratory is carried on without financial assistance from the National Research Council. Some associated work in breeding for rust resistance is also carried on at the Dominion Experimental Station, Brandon.

Annual stem-rust surveys have been made in Canada for the past 13 years to determine the prevalence of physiologic forms. The information gathered has now been summarized and a study made of the factors that govern the distribution and prevalence of physiologic forms. A number of complicated factors are involved, such as climate, the proximity of the wheat areas to barberry bushes, the length of the uredinial periods of the different forms, the susceptibility of the wheat varieties grown, and the general contour of the land in different parts of the country.

Since the solution of the stem rust problem seems to be reasonably near, a study of leaf rust, the second most destructive rust of wheat in Canada, has been undertaken. Some 15 forms have already been identified. It appears that there would be a distinct advantage in classifying physiologic forms of the rusts into group forms, rather than into individual physiologic forms.

In experiments to determine whether or not ultra-violet rays affect the uredinial or telial development of the stem rust of oats, it was found that such radiation has no appreciable effect when its intensity is not lethal or seriously injurious to the host.

On the basis of the results obtained in determining the rust reaction of a resistant variety of wheat at various stages of maturity, and in the sectioning of plant tissue, it was found, first, that newly formed tissue in old plants is susceptible but that within a comparatively short time physiological changes take place in the same tissue which practically inhibit all rust development; and, second, that there is no correlation between rust development and the morphology of susceptible or resistant host tissue.

Owing to the unusual prevalence of "black point" in the wheat crop in 1931, some alarm was felt by the grain trade regarding the possible increase of this condition in future crops. Experiments were commenced to determine the relation of the disease to the viability of the seed and its market value. The durum wheats were more heavily diseased than the common or bread wheats. The disease could be controlled by dusting with sulphur during and after the blossoming stage of the crop. Plants from seed injured through imperfect threshing are more susceptible to foot-rots.

Bunt in both hard red spring wheat and amber durums was considerably reduced in 1931. In seed treatment experiments the formalin immersion method continued to give the most satisfactory control with heavily infested samples of grain. When nine varieties of barley were inoculated with three collections of covered smut spores, there were indications that these smut collections represented different physiologic forms. Marked varietal differences were noted in the reaction of barley to loose smut.

Since 1928 the black chaff disease of wheat has been an important factor in breeding work. The identity and symptoms of the disease are not clear and need further study. Experiments seem to indicate that the black chaff pigmentation is due to a disturbed physiological balance in the plant, which can be induced easily by the black chaff organism.

The exceptional drought during the 1931 season was very opportune for studying the factors affecting yield under such conditions. Early varieties gave very low yields. Time of maturity gave a high correlation with yield. There was an average increase of 1.5 bushels of wheat per acre for an increase of one day in time of maturity. In studying the inheritance of rust resistance in a durum cross, Iumillo x Mindum, it was found that: (1) the greenhouse and field reactions are not directly associated; (2) the field reaction is controlled by one main pair of factors and modifiers; (3) the modifiers are probably the factors connected with the seedling reaction; (4) at least three pairs of factors operate.

Smut did not affect rust development in oats under greenhouse conditions, while under field conditions smutted plants were more susceptible to rust. Plants from seed inoculated with smut spores, but which show no evidence of smut infection in the panicles, may be infected with smut mycelium and their general vigor consequently impaired. Covered smut exerts a greater influence than loose smut in reducing height and tillering.

(Investigations under the direction of Drs. J. H. Craigie and C. H. Goulden.)

Research at the University of Alberta

Experimental studies comparing the relative development of foot-rot diseases of wheat on sterilized and unsterilized soil at different constant soil

temperatures were carried out with *Ophiobolus graminis*, the causal organism of take-all. The seedlings were severely attacked at all temperatures in the sterilized soil, but were killed most rapidly at 27°C. In the unsterilized soil there was little damage at 27°C., but severe damage at 13°C. These results may be explained on the grounds that the saprophytic micro-organisms in the unsterilized soil are more active at the higher temperature and hence have a greater inhibitive action on the pathogene than at the lower temperature. The greater severity of the take-all disease on winter wheat as compared with spring wheat may be attributed to the differences in soil temperatures.

Isolation studies of foot-rotting fungi in the soil under different cropping systems indicate that the cropping system does have some effect on the abundance of the fungi in the soil. The differences, however, may not be sufficiently great to influence markedly the severity of infection of wheat grown on the different soils.

Ophiobolus graminis is a fungus which often does not sporulate readily, especially in artificial culture. Observations from cultural studies have suggested that the presence of other micro-organisms might stimulate the formation of ascospores in *Ophiobolus*. One of the cultures appeared to be homothallic. Overwintering studies indicate that *Ophiobolus graminis* can in all probability overwinter at Edmonton in both the mycelial and ascospore stages.

(Investigations under the direction of Dr. A. W. Henry.)

The production of improved varieties of barley resistant to stripe, covered smut and loose smut is well under way. New inoculation methods have been developed for these diseases and also an improved chemical method for removing the hulls from barley kernels for the smut studies. Two physiologic forms of *Ustilago hordei*, the causal organism of covered smut, have been found. A detailed genetic study is being carried out in a cross between Trebi and Glabron. The latter variety is smooth-awned.

A comprehensive statistical study has been made on the variation in morphology of six varieties of wheat inoculated separately with five physiologic forms of bunt. It was found that the two species *Tilletia tritici* and *T. levis* could not be distinguished on the basis of the host reactions, since there were no differences on most varieties of wheat, and on others physiologic forms within the species showed as wide differences as forms belonging to the two different species. All varieties of wheat, even though bunt-free showed, when inoculated, signs of being infected, as was indicated by shorter culms and smaller seed than in plants not inoculated.

A number of apparently superior varieties of spring wheat have been produced which are practically immune to bunt, highly resistant to rust and relatively free from damage by foot-rots.

(Investigations under the direction of Dr. O. S. Aamodt.)

The investigation of the phenolic compounds of the wheat plant in relation to rust resistance, carried on for the National Research Council at the University of Alberta during the year, is described in the report of the Division of Biology and Agriculture, page 22.

(Investigation under the direction of Dr. R. Newton.)

Research at the Dominion Laboratory of Plant Pathology, University of Alberta

The relative effectiveness of various time-strengths of cold formaldehyde and of non-acidulated and acidulated mercuric chloride, in killing small, medium and large *sclerotia* of *Rhizoctonia solani* on the surface of potatoes, was determined. Evidence from plating treated sclerotia showed that where small or medium sclerotia are concerned, the solution of either acidulated or non-acidulated mercuric chloride was effective up to the fifth successive treatment and, for practical purposes, probably up to the eighth, by extending the time. The sclerotia varied in texture as well as in size. Evidence so far obtained indicates that natural soil infestation is as effective in producing disease as are sclerotia on the tubers or on added culture. Greenhouse and laboratory tests in pure culture show that a fairly wide range of pathogenicity of this fungus exists in nature.

In the root-rots of cereals, abundant evidence has been obtained to show that, in greenhouse culture, inoculum of several common organisms known to be pathogenic to wheat rapidly becomes inactivated owing to the foreign growth of bacteria and fungi. The results explain in a general way why the addition of inoculum fails to produce definite results in field experiments.

In histological studies on the root-rots of cereals a marked increase in the amount of lignified tissue was found to take place with advancing age, reaching a maximum in about 40 days after planting. The increase in lignification occurs chiefly in the xylem, the pericycle, the fibres of the vascular bundle sheaths, and in the subepidermal layers of the cortex of the crown roots. The cells of the latter become much thickened with advancing age.

In greenhouse tests the effect of fertilizers on take-all was studied. In sand cultures, iron and copper reduced the disease greatly; calcium, sulphur and phosphorus-nitrogen combination slightly; and phosphorus or a phosphorus-potassium combination, or potassium-nitrogen, possibly reduced the disease a little, while potassium or nitrogen separately, or a phosphorus-potassium-nitrogen combination had no effect on the disease.

(Investigations under the direction of Dr. G. B. Sanford.)

Research at the Provincial Plant Pathology Laboratory, Saanichton, B.C.

A new stem-end rot disease of potato has been found, caused by an organism not previously reported. The new organism has been named *Phomopsis tuberivora* and the disease which it produces is being called "stem-end hard-rot." At the proper storage temperature for potatoes, the fungus does not make much progress. Mercuric chloride treatment did not prove to be an effective control measure.

In the investigation of the fruit blight of raspberry and loganberry, *Bacillus desiccans*, another bacillus and a species of *Cephalosporium* were found to be associated with the disease. Results indicate that fruit blight may be controlled by destroying insects commonly found on blossoms. One of the best raspberry varieties, the Cuthbert, was found to be resistant to the disease.

(Investigations under the direction of Mr. W. R. Foster, supervised by Dr. W. Newton.)

Research at the University of Manitoba

The testing of new rust-resistant strains of wheat in comparison with the standard varieties recommended for Manitoba was continued in 1931. In the absence of rust some of the new varieties yielded as well as the best standard varieties, while in 1930, under severe rust epidemic conditions, they yielded higher.

Since the acreage devoted to barley production in Manitoba is practically equal to that of wheat, a comprehensive breeding program has been projected with special attention being devoted to disease resistance and malting quality. Artificial epidemics with the foot-rotting fungi have been successful, there being an appoximate increase in severity of infection on the inoculated plots of 50% over that of the checks.

(Investigations under the direction of Prof. A. T. Elders.)

Research at the University of Saskatchewan

In the 1930 pathogenicity experiments with *Pythium*, the causal agent of the browning root-rot disease on cereals, no outstanding differences between inoculated and uninoculated plots were noted, presumably owing to the dry condition of the soil. In 1931 water was applied to the soil and typical *Pythium* damage occurred. The results between different lots of inoculum and dates of seeding were inconsistent and it was concluded that a more accurate idea of the relative pathogenicity of the various parasites could be obtained in the greenhouse. Effects of fertilizers, however, will probably have to be studied in the field.

A *Pythium* has been found which is especially pathogenic on flax. It is felt that much of the seedling damage to flax which has hitherto been attributed to *Fusarium lini* (wilt), has actually been caused by *Pythium sp.* and perhaps to a lesser extent by *Rhizoctonia sp.* This *Pythium* is severely parasitic on dicotyledonous plants and only slightly so on cereals and crested wheat grass. The *Pythia* on the cereals are the reverse, so a rotation including both monocotyledonous and dicotyledonous plants is advisable.

(Investigations under the direction of Prof. T. C. Vanterpool.)

Genetic results have been interpreted as showing that the characters which distinguish common wheats from durum and emmer types are carried in the extra seven *vulgare* chromosomes. It is important to determine what durum characters can be transferred to *vulgare* types and *vice versa*. A number of *vulgare* conditions have been found fully developed in 14-chromosome plants, others only partially so, and some not at all. Some *vulgare* characters not found in 14-chromosome plants have been found in 15-chromosome plants. Durum characters not found in 21-chromosome plants agree well with the list of *vulgare* characters not found in 14-chromosome plants. Evidence has appeared that some characters are conditioned by genes in both the primary 14 and the extra 7 chromosomes. For some characters reciprocal crosses were not the same.

In studying the germination of the F_1 pollen it was found that the grains which are retarded in development are those with chromosome numbers intermediate between those of the parental species. The failure of many pollen grains to produce offspring is due to their failure to germinate.

(Investigations under the direction of Dr. W. P. Thompson.)

A detailed genetic and plant breeding study in a cross between H_{44}-Double Cross × Marquis has resulted in the production of several hybrid lines, at least one of which should prove to be a satisfactory solution of the rust problem in Saskatchewan. From approximately 20 other crosses a number of promising rust resistant lines are being recrossed with Reward and Quality for the attainment of increased earliness.

(Investigations under the direction of Dr. J. B. Harrington.)

Research at the Dominion Laboratory of Plant Pathology, University of Saskatchewan

Isolation studies on the fungus flora of wheat crowns and roots have been continued. When isolation studies are made throughout the season there appears to be a tendency for *Helminthosporium sativum* to increase as the season advances. In the case of *Fusaria* the reverse is often evident but the results are not consistent in this respect. The same type of fungi can be isolated from Marquis wheat grown at widely separated points in the wheat areas of western Canada. If the *Fusarium* isolations were analyzed into species there would probably be some regional differences.

A study of moisture relations in take-all disease has shown that the disease is most severe under dry conditions in the greenhouse. Inoculated wheat sown four inches deep showed more damage than when sown at two inches. Take-all tends to increase in old fields when wheat is sown for several years in succession. Marquis, Garnet, Reward and Mindum were injured by this disease to about the same degree.

In the studies with *Helminthosporium sativum* the modified spore suspension method was the most successful method of inoculating. Best results were obtained when the suspension of spores was permitted to dry on the seed after an incubation period of from 27 to 47 hours.

(Investigations under the direction of Dr. P. M. Simmonds.)

Associate Committee on Gas Research

Co-operating organizations:

Alberta Research Council
Calgary Institute of Technology
Federal Department of Mines
University of Alberta

During the year public concern over the enormous wastage of natural gas in Alberta has increased and steps have now been taken which it is hoped will lead to a reduction in this loss. In the meantime the committee had continued its efforts to devise methods for the chemical utilization of the gas, work having been carried on not only in the National Research Laboratories at Ottawa but also in the laboratories of the University of Alberta at Edmonton and at the Calgary Institute of Technology, in both of which places the investigations have been jointly supported by the Alberta Research Council and the National Research Council.

An account of the work in the National Research Laboratories is given on page 26, under the report of the Division of Chemistry. This work has been planned to supplement the experiments under way in Alberta.

At a meeting of the committee held in Edmonton on June 20, 1932, Mr. P. D. Rosewarne of the Federal Department of Mines reported on

analyses of natural gas made by the Department since the previous meeting of the committee. The objective of the Department is to secure samples of gas from all new wells as brought in, in order to determine the composition of the gas and in particular its helium content, since an Empire source of helium is greatly desired. No commercial sources have yet been discovered in Canada, although nearly all natural gas contains at least a trace of helium.

A study has been made by the Department of gas lost by the weathering of crude naphtha in the Turner Valley. This process, which is necessary in order to reduce the volatility of the naphtha to the point where it can be safely shipped, results in the loss of hydrocarbons of considerably greater interest from the point of view of chemical utilization than natural gas itself. The recoverable propane, butane and higher hydrocarbons have been estimated.

Dr. E. H. Boomer of the Alberta Research Council reported to the committee that in his hydrogenation experiments on bitumen from the Alberta tar sands he had found it possible to convert at least 75% of the bitumen to gasoline and light oils and 10% to gas, about 15% remaining as resistant asphaltic compounds. The hydrogenation of coal had been greatly improved in recent work through the use of a more suitable medium, tetralin, which had proved of great value as a hydrogen carrier. Through its use all coals of lower rank could be hydrogenated with a good yield of oil, only semi-bituminous and higher coals being resistant under the conditions of the experiment. The conversion obtained in some cases was better than 90%. It is questionable, however, whether hydrogenation can be carried out commercially in Alberta in competition with gasoline cheaply available from other sources.

Some work had been done by Dr. Boomer on water gas which can be manufactured cheaply from natural gas. Methyl alcohol can be readily produced, but conditions were not found favorable to the production of ethyl alcohol.

During the year Dr. Boomer had brought to a conclusion his work in the university laboratory on the pyrolysis of Viking natural gas, which consists almost exclusively of methane. Fair yields of benzene had been obtained and in order to study the possibility of producing larger quantities of benzene from the richer gas of the Turner Valley the experimental work had been transferred to Calgary where the latter is available. Modifications in procedure had been found necessary in operating there on a somewhat larger scale, but the difficulties were being overcome and a fair recovery of benzene was being obtained. Small-scale experiments had also been begun on the pyrolysis of weathering gases, from which larger yields of benzene were anticipated.

Associate Committee on Grain Research

Co-operating organizations:

Board of Grain Commissioners for Canada
Dominion Department of Agriculture
Macdonald College
University of Alberta
University of Manitoba
University of Saskatchewan

The committee has continued to sponsor co-operative investigations on factors affecting the milling and baking quality of wheat. These investigations are divided into projects as follows:—

1. Drying of wheat.
2. Frost injury.
3. Variety tests.
4. Methods of harvesting.

Reports on the first three projects have been prepared for publication during the year; the fourth project is new, and work on it will be commenced this summer. The experimental work on these projects is carried on co-operatively at the three universities. Fundamental research on special problems arising out of the co-operative program is carried on independently by the universities. A study of the literature on grain rations was made during the year at Macdonald College.

Twelve papers have been approved for publication during the year, making a total number of 33 in the committee's series. The first volume of collected papers, including numbers 1 to 20 of the series and two reports on the feasibility of using protein content as a factor in grading wheat, is in preparation.

Co-operative Investigations

Drying of Wheat

The experimental work on this project was completed last year. This year's work consisted of the analysis of the data obtained and the preparation of a report, which will be issued as Research Council Bulletin No. 25. A summary of this work appeared in the annual report for 1930-31, p. 71.

A test of the new A. B. Svenska Maskin Verken drier installed in the government elevator at Lethbridge was made for the Board of Grain Commissioners. Three lots of wheat were dried without injury to the milling and baking quality.

Frost Injury of Wheat

A report on the milling and baking quality of the 1928 wheat crop has been published (Can. J. Research, 6: 119-155). An annual survey of the quality of frozen wheat is being continued with a view to checking the general validity of the conclusions drawn from the study of the 1928 crop.

The effect of storage on the artificially frozen series of samples produced in 1930 has been investigated. The conclusion that the baking quality is not injured when the wheat contains less than 42% moisture at the time of freezing is still valid after the flour has been stored for six months. The seed value of these artificially frozen samples was determined in 1931, in co-operation with the Dominion Seed Laboratory, Calgary.

Quality of Wheat Varieties Grown in Western Canada

To maintain the quality of Canada's export wheat it is essential that only high quality varieties should be grown. To supply information on which a choice of varieties may be based, a co-operative study was made of the milling and baking quality of 25 varieties of spring wheat now grown in western Canada. Samples were grown in adjacent plots by the Dominion Experimental Farms and Universities in Manitoba, Saskatchewan and Alberta in 1928, 1929 and 1930. Only samples which were sound enough to be placed

in the statutory grades by official inspectors were used. Part of each sample was milled and baked in each of the three co-operating laboratories. Four baking formulas were used. The varieties were classified on the bases of loaf volume, texture, crumb color, general appearance of loaf, absorption, and yield of straight flour. These classifications were combined to give classifications for baking quality and milling quality and finally for suitability for export and domestic milling. The last classification is as follows:—

1. Varieties which are entirely satisfactory: Reward, Ceres, Marquis, Pioneer, Red Fife, Renfrew, Red Bobs 222, Supreme.

2. Varieties which are fairly satisfactory: Early Red Fife, Ruby, Early Triumph.

3. Varieties which are unsatisfactory: *(a)* White wheats: Quality, Axminster, Hard Federation; *(b)* Varieties differing from Marquis in milling characteristics: Garnet, Kota; *(c)* Varieties inferior to Marquis in baking characteristics: Garnet, Parker's Selection, Brownhead, Huron, Kitchener, Preston, Marquillo.

4. Varieties which are very unsatisfactory: Early Prolific, Dicklow, Vermilion.

The full report covering this investigation has already been published (Can. J. Research, 6: 333-361. 1932).

Effect of Harvesting Methods on the Quality and Storage Properties of Wheat and Other Grains

During the last three years elevator companies and farmers have suffered considerable losses through grain harvested by means of combines going out of condition in storage. The committee has initiated an investigation of the effect of combining and other methods of harvesting on the keeping qualities of grain. The general scope of this investigation is as follows:—

1. Moisture and grade survey.
   (a) Moisture range throughout the day in the standing crop.
   (b) Moisture and grade of samples collected from farms at time of harvesting and threshing.
   (c) Moisture and grade of samples as delivered at country elevators.
2. Storage in farmers' bins.
3. Sweating in barge stacks.
4. Laboratory study of sweating.

Co-operation with Plant Breeders

Under a co-operative arrangement with the plant breeders of the Associate Committee on Field Crop Diseases, eight samples of wheat from the Dominion Rust Research Laboratory were tested.

Independent Researches at the Universities

Grain Research at the University of Alberta

The investigations of the effect of timothy, brome, western rye grass and alfalfa on the yield and quality of succeeding wheat crops are being continued. In the dry seasons of 1929 and 1930, such differences as were found had been confined to the yields. In the moist season of 1931, however, wheat after alfalfa was significantly higher in protein, and wheat after brome significantly

lower than wheat following the other two grasses. It is interesting to note that the soil flora in the plots following brome was characterized by an abundant growth of *Penicillium*.

The differences obtained in the above experiment are particularly noteworthy since in other rotation experiments in 1931, involving nine different combinations of cereals, flax, sweet clover and fallow, there were no significant differences in the protein content of the wheat in the different rotations.

Experiments on the relation between yield and protein content of wheat were repeated with substantially the same results as last year. The correlation between the yield and protein content of 50 eighteen-foot rows selected at random over a single field was $-0.49 \pm .07$.

NOTE: Other grain researches financed and directed by the National Research Council at the University of Alberta, will be found summarized in the report of the Division of Biology and Agriculture, page 20.

(Investigations under the direction of Dr. R. Newton and Dr. J. G. Malloch.)

The plots under alfalfa, timothy, western rye grass, brome grass, and wheat following these crops (and a fallow plot in another part of the field) were sampled throughout the season. The samples were analyzed for nitrates, soluble phosphorus, and numbers of bacteria and fungi.

The nitrates in the sod plots were higher than in previous seasons, as the rainfall was higher, but nitrates were still considerably lower than under wheat. Under the first crop of wheat following the sods in sub-block II (broken in 1930), the alfalfa plots were highest in nitrate and the brome plots lowest, thus corroborating results previously obtained under the first crop of wheat in sub-block I (sods broken in 1928). Under the third crop of wheat in sub-block I the differences were smaller but the alfalfa plots still contained most nitrate and the brome least. There is now a great deal of evidence, when the four sods studied are compared, that nitrates are produced most rapidly following alfalfa, and least rapidly following brome. In the latter half of the season the nitrates were, as usual, higher in the supplementary fallow plot than in any other plot.

Water-soluble phosphorus was determined by a method which includes both organic and inorganic phosphorus. The surface samples were relatively high in water-soluble phosphorus. No great differences between the plots under the different crops could be detected, but there were indications that the concentration of water-soluble phosphorus under the forage crops, and especially under alfalfa, was higher than under wheat.

Generally speaking the differences in bacterial numbers between different plots were not very significant. Under the first crop of wheat following sods in sub-block II, the numbers were higher following alfalfa than following the grasses, thus corroborating results previously obtained in sub-block I.

The counts of fungi in the sod plots were highest under alfalfa, as in the two previous years. As in previous years, also, the differences between timothy and western rye grass plots were not significant. The brome plots, included in the microbiological counts for the first time, gave the lowest counts of fungi. Under the first crop of wheat following sods it was again observed that large *Mucor* colonies predominated in the alfalfa plots. It was also noticed that under the first crop of wheat following sods, the brome plots gave by far the highest counts of fungi, and these consisted mainly of small *Penicillium* colonies. A definite relation between the kind of sod plowed

down, the kind of fungi bringing about its decomposition, and the rate of nitrate production has thus been observed in the cases of alfalfa and brome grass. Under wheat following timothy and western rye grass, the numbers of fungi were much smaller than following brome, and consisted mainly of *Penicillium* colonies. In the supplementary fallow plot the numbers of fungi were smaller than in the previous seasons, but the plot was located at some distance from the main experiment, and is therefore not strictly comparable.

(Investigation under the direction of Dr. J. D. Newton.)

Grain Research at the University of Manitoba

The study of the influence of commercial fertilizers on the protein, ash and phosphorus content and milling and baking quality of Manitoba-grown red spring wheat is being continued. On the completion of the experimental work on the 1931 crops, data will be available for three consecutive years.

Nitrogenous fertilizers drilled in just below the seed at the time of planting raise the protein content of the wheat slightly, while phosphatic fertilizers have a tendency to depress the protein content slightly. None of the fertilizers had any significant influence on the phosphorus content of the wheat. Milling and baking studies have not been completed on the 1931 crop but the results for the previous two years indicate that none of the fertilizers had any significant effect on wheat quality with the exception of the treatments in which nitrogen was included. When baked by the bromate formula flours milled from wheats fertilized with either ammonium sulphate or sodium nitrate gave significantly larger loaf volumes than the control samples.

The studies begun two years ago on the effect of germ constituents on the baking quality of flour have been continued. During the past year the work has been confined largely to the biochemical changes occurring during the aging of wheat germ and the influence of these changes in relation to the effect of germ on the baking behavior of flour-germ mixtures. Wheat germ was aged at two moisture levels in an apparatus which permitted the collection and subsequent measurement of the carbon dioxide respired. As the germ was permitted to age its deleterious effect on baking quality gradually became less. Biochemical studies showed a pronounced increase in titratable acidity and decreases in lipoid phosphorus and lipoid nitrogen, as aging progressed. The higher the moisture content the more rapidly these changes took place and the less the effect of the germ on baking quality of the flour-germ mixtures. As the lipoid phosphorus decreased, the response to the addition of bromate to the baking formula became less, and this observation, together with similar results obtained in other studies, indicate that the response to bromate may be closely related to the quantity of phosphatides present. It has also been observed that the lipoid phosphorus content of bread doughs decreases as the fermentation progresses and that the addition of bromate brings about a very rapid decrease. Gas production and retention measurements have shown that while bromate has no influence on the rate of gas production in bread doughs, it has a marked effect on gas retention, indicating that it has some action, either direct or indirect, on the gluten proteins. The experiments which have been conducted in this laboratory suggest that the effect of bromate may be related, at least in part, to the percentage of phosphatides present.

In connection with the studies on the aging of wheat germ it was found necessary to determine with considerable precision the iodine values of the fatty acids liberated from the extracted lipoids. None of the established methods gave satisfactory results and special apparatus and technique were

developed whereby the entire series of operations could be carried out in an inert atmosphere. As a side issue to this work, the entire technique of the iodine value determination was subjected to a critical examination, a number of interesting points brought out and an improved technique developed.

(Investigations under the direction of Dr. W. F. Geddes.)

Grain Research at the University of Saskatchewan

The most important problem on hand at present is that of environmental influence on quality of wheat grown in Saskatchewan. This study, which has been generously supported by the Saskatchewan Agricultural Research Foundation, is now in its seventh year. One of the principal results of this work to date has been the demonstration that protein content and baking quality are very closely correlated. Both of these factors are in turn related to rainfall and character of the soil. The study has advanced far enough to show that rainfall alone cannot account for the variation noted in a given season; the physical character of the soil must be considered in conjunction with the precipitation.

An extensive study of viscosity of flour-water suspensions has been made and it was found that the viscosity of the unleached suspensions is correlated with loaf volume to the same degree as protein content, when flours from sound wheat of one variety are considered. Qualitative differences between Marquis and Garnet have been demonstrated by this method. When applied to flour milled from frost-damaged grain, the differentiation between samples is not as good as in the baking test, but a very marked decrease in viscosity occurs in the lower grades. There is very definite differentiation between grades No. 4 Nor., No. 5 and No. 6.

During the past two years Mr. S. F. Brockington, has conducted a study of the fermentation process. Using Bailey and Johnston's technique for measuring carbon dioxide production and retention, he has examined a number of flours and observed their behavior when baked by 36 modifications of formula, in respect to the amounts of sugar and yeast, and length of fermentation time. Results of baking tests and carbon dioxide production were obtained. From this work it was concluded that both the bromate and simple formulas in use at present are inadequate as general tests for baking quality of experimental flours milled from western Canadian hard red spring wheat. Additional work with the most promising of the formulas is being carried on at present. No decision regarding modification of the formulas can be reached until this is completed.

A study was made of the relation between the average baking results of a number of individual flour samples and those of a composite flour sample made up by combining aliquots of the individuals. Part of this work has been published and the remainder will be ready in a short time. It was concluded that composites give results that are not significantly different from the averages of many individual tests, provided that the mixing is confined to one variety. It seems probable that this limit could be expanded to include wheat of one class. The only disadvantage in the use of composite samples is that no estimate of variability can be made, but for all work in which the viariability is not an important factor it seems advisable to use composites because the reduction of work is so great that a much more thorough examination of the material in hand can be made. It appears more desirable to bake one composite sample by five baking formulas than to rely upon ten individual samples baked by one formula.

In collaboration with Dr. J. B. Harrington a study of variability of protein content in plots seeded at different times is being carried on. This work has not yet advanced far enough to warrant conclusions.

Five flours were extracted with five different gasoline fractions, and the color of the extract was compared by means of the Duboscq colorimeter, using potassium chromate as a standard. The greatest source of error appeared to be due to differences obtained on different days. Replicates made on the same day showed very low variability but when made on succesive days the error was quite high. The differences occurring as a result of using different gasolines are relatively small.

(Investigations under the direction of Dr. T. Thorvaldson and Dr. R. K. Larmour.)

Grain Research at Macdonald College

The low market price of barley was the immediate reason for investigating its feeding value in comparison with other home-grown grains, and with corn, which is largely imported. A comprehensive review of the literature on feeding experiments with farm live stock was undertaken. Data covering something like 1,700 comparisons have been assembled and are being analyzed statistically. It has become clear that rate of feeding is an important factor in both amount and economy of gains. In many cases much of the difference in the efficiency of comparative rations, as measured by the gains per unit of feed eaten, can be accounted for by differences in the quantity of the rations, though in some cases such differences have been attributed by the experimenter to supposed differences in the quality of the rations. When the level of intake of total digestible nutrients and of protein is taken into account, the apparent differences between rations are still further reduced. Other factors influencing the efficiency of the ration include its content of crude fibre and its preparation by grinding. Age and size of animals, and their management, also affect the rate of economy of gains. A report will be published during the coming year.

(Investigation under the direction of Prof. E. W. Crampton.)

Associate Committee on Iodized Salt

Co-operating organization:

Federal Department of Health

Following the recommendations of a conference on iodized salt, held late in 1930, the National Research Council appointed an Associate Committee on Iodized Salt, with representation from the Federal Departments of Agriculture and Health, the Connaught Laboratories and the Universities of Manitoba, McGill and Toronto. This committee held its first meeting in Ottawa on March 4, 1932.

A communication was received by the committee from Dr. O. J. Walker of the Department of Chemistry at the University of Alberta regarding an iodine survey being made by him in that province. The committee expressed its interest in the work being carried out by Dr. Walker.

There was presented to the committee a report on iodized salt prepared by Miss M. E. Whalley of the Division of Research Information and embodying the results of a survey carried out by the Council on the prevalence of goitre and the distribution of iodized salt throughout Canada. The survey showed goitre to be practically absent in Nova Scotia and New Brunswick

and quite uncommon in Quebec. In Ontario, its prevalence is quite noticeable at Kingston, increases about the Muskoka district and in the vicinity of Windsor, still increases from North Bay to Cochrane, and from Sudbury to Sault Ste. Marie, then diminishes again at Port Arthur and Fort William. It has also been found to be prevalent in Saskatchewan in the vicinity of Prince Albert, while in Alberta and British Columbia it diminishes again, particularly on the coast.

A survey of the comparative sales of free running and iodized salt in Canada for 1929 and 1930 shows that in the districts where goitre is prevalent there is a greater sale of iodized salt than of free running, and where goitre is uncommon, the sale of iodized salt is much less. In most districts the proportion of iodized salt used is increasing.

After a detailed consideration of Miss Whalley's report the committee reached the following tentative conclusions:—

(1) That iodine is required by all animals, including man, and especially those in the pregnant condition.

(2) That since the iodine content of food and drinking water varies greatly throughout Canada the necessity for the administration of iodine also varies in different parts of the country.

(3) That the method of administering iodine as sodium iodide or potassium iodide in salt is satisfactory.

(4) That the proportion of potassium iodide now used in iodized salt in Canada, one part in 10,000, is unnecessarily high. It is considered that one part of sodium or potassium iodide in 200,000 would be sufficient and that one part in 100,000 would be satisfactory as a maximum.

(5) That the addition of iodides to the soil may be expected to increase the iodine content of plant foods grown thereon, but this procedure is considered to have no special advantage over the direct administration of iodine in iodized salt and is regarded as very wasteful.

(6) That consultations with the manufacturers are required regarding methods of mixing and storage, in order to provide for a reasonably constant amount of iodine in table salt.

(7) That the National Research Council should undertake in conjunction with the manufacturers such research as may be necessary to give effect to the committee's recommendations.

(8) That if an iodine survey of food and water supplies in Canada is to be carried out, it should be undertaken by a national body such as the National Research Council.

(9) That the widespread sale of endocrine preparations containing thyroid is inadvisable from the standpoint of the health of the community, except under a doctor's prescription, and that otherwise the sale of these preparations for the treatment of goitre or obesity cases should not be permitted.

(10) That the question of the compulsory iodization of salt be kept on the agenda for future discussion.

(11) That when the necessary information has been obtained the Department of Pensions and National Health be asked to provide statutory regulations.

Following the recommendations of the committee, steps are being taken by the Council to get in touch with manufacturers regarding the problems of mixing and storage of iodized salt.

Associate Committee on Laundry Research

Co-operating organization:

Eastern Canadian Laundryowners Association

A meeting of the committee was held in Toronto on November 24, 1931, for the presentation of reports and further consideration of a research program.

Dr. Morgan of the Division of Chemistry reported on investigations carried out by him in the National Research Laboratories. Much time had been spent on service work for commercial laundries, especially on the study of injury to fabrics. In addition, tests had been made to determine the efficiency of detergents with variation of temperature, time and methods of operation of machinery. An outline of Dr. Morgan's work appears on page 33 of this report.

Bleaching practices were discussed at some length. The merits of certain bleaching agents were considered and their effects upon fabric noted. The committee considered the advisability of undertaking an investigation of winter damage, said to be due to the action of sulphur dioxide. The National Research Council is in a particularly good position to study this problem on account of the extensive experience gained by its staff in the Trail smelter smoke investigation.

An account was given by Dr. Morgan of his visits to various laundries and research laboratories in the United States. Work under way in these places was reviewed.

The relation of the work of the committee to textile research was emphasized. It is obvious that certain problems are common to both the laundry and textile industries.

Attention was called to an error in a published report on washing rags, in which there was some confusion between caustic soda and washing soda. The proper authorities had been notified of the error.

Associate Committee on Leather

Co-operating organizations:

British Leather Manufacturers' Research Association
Tanners Association of Canada
Tanners Section, Toronto Board of Trade
Technical Association of Canadian Leather Belting Manufacturers

During the year Mr. C. H. Cleveland, the representative of the Technical Association of Canadian Leather Belting Manufacturers, resigned from the committee and Mr. S. G. Bennett was appointed in his place. Mr. Chas. H. Annabel was also appointed to the committee.

At a meeting of the committee held in Toronto on November 23, 1931, Dr. Graham reported that a summary of the publications of the British Leather Manufacturers' Research Association on beam-house work had been prepared by him and distributed to the members of the committee. Later on other reports of the association were dealt with in a similar way.

Since the previous meeting of the committee a survey of damage by the warble fly in Canada had been made by Dr. Graham and a report had been distributed. The loss in 1930 was estimated at $700,000, without making

any allowance for the reduced production of beef and milk. In some years the losses were considerably greater than this amount. The committee has co-operated with other organizations in educational work regarding the warble fly in order to inform the farmers and others of the serious nature of this pest. Much of the loss has been observed to fall on the tanners and it was felt by the committee that farmers would not fully appreciate the seriousness of the warble fly until these losses had in some way been passed back to those who held the remedy in their own hands.

The committee discussed the problem of "red heat" of hides, which appeared to be due to salt-loving organisms. It was decided to make a study of this question.

Dr. Whitby presented to the committee a summary of the information which had been obtained regarding sulphite liquor tans. An effort is to be made to determine whether Canadian sulphite liquor can be economically used for tanning purposes.

Methods of rapid tanning were discussed at some length by the committee. There is some uncertainty as to whether these methods will be of any considerable benefit to Canadian tanners, but it has been agreed that information regarding the methods should be distributed to the industry.

Arrangements have been made during the year for chemical tests on leather belting and it is hoped that the National Research Laboratories will shortly be able to make mechanical tests as well. The necessary machinery is to be set up in the new building as soon as it is complete. There was presented to the committee a report on the utilization of waste leather, prepared by Dr. C. A. MacConkey of the Division of Research Information. This problem is one of general interest to the tanners of Canada.

It was reported that inquiries had been received regarding sumac tannage and possible sources of this material. In view of the tanners' interest in this question the Division of Research Information was asked to prepare a report covering it. This has since been done.

Leather research carried out in the National Research Laboratories by the Division of Chemistry is described in this report beginning on page 30.

Associate Committee on Magnesian Products

Co-operating organizations:

Canadian Refractories Limited
Federal Department of Mines

As in the previous year, frequent conferences have been held of the technical staffs of all the co-operating organizations. At these conferences researches have been planned only after careful consideration of the principal technical and economic questions involved. Experiments have been laid out systematically and the results obtained have been periodically examined. To this method of operation it is believed that the success of the investigation is in large part due.

On account of the economic depression it was decided to defer further research on a number of minor problems not offering the possibility of immediate large-scale utilization of magnesian products and to concentrate on those likely to be of the greatest commercial importance. It is anticipated, however, that these minor problems will be taken up as soon as opportunity

affords, since leads have already been obtained which indicate the possibility of developing new products and of securing many new applications of products already on the market.

Further improvements have been effected in the mining and treatment plants of the co-operating companies, these resulting in greater efficiency of operation and in the maintenance of the high standard of quality of the various products.

New uses have been sought for the refractories which constitute the companies' principal products and in this work considerable success has been attained. In co-operation with the technical staff of Noranda Mines, Limited, a monolithic bottom of magnesian clinker and roll scale in suitable proportions has been burned in the copper anode furnace at Noranda, Quebec. This new development, which has been fully described elsewhere (Boggs, Anderson and Westwood, Canadian Mining and Metallurgical Bulletin, April, 1932), has proved eminently successful and the further use of magnesian clinker in this field is anticipated.

Commercial application is also being made in steel and copper metallurgy of magnesian cement and of a mixture which may be rammed into place with a suitable bond to form refractory linings for furnaces. Laboratory researches on both these products, which are made from the regular magnesian clinker, are being continued.

The present depression in the steel industry, where most of the magnesian clinker has been used, has naturally had an influence on sales, but relatively speaking the Canadian products have more than held their own.

As stated in the last annual report, brick made of magnesian clinker and chromite have been manufactured experimentally in commercial plants, and trials of the brick produced are now under way in steel furnaces in comparison with other refractory brick. While considerable time is required to fully demonstrate the value of such products, the observations to date are highly encouraging. It is anticipated that arrangements for the commercial manufacture of these brick in England will be made in the comparatively near future. Laboratory work on brick has been confined to a determination of the best source of raw materials and to details of manufacturing methods.

The work on plastic magnesia is described in the report of the Division of Chemistry, page 25. It may be mentioned here, however, in respect to this development, that the practice has been maintained of carrying each branch of the investigation to the commercial stage. During the year members of the staff have supervised both the commercial manufacture of plastic magnesia and its utilization in the laying of 125,000 square feet of floors.

(Investigation under the direction of Mr. F. E. Lathe.)

Associate Committee on Oceanography

Co-operating organizations:

Biological Board of Canada
Meteorological Service of Canada
Pacific Committee on Oceanography (U.S.A.)
University of British Columbia

As in former years, since the members of the committee are so widely scattered, it was not considered necessary to have a meeting of the entire

committee. The chairman, Dr. C. McLean Fraser, has been in touch with each member by correspondence and had discussed matters of moment with nearly every member personally, at least once during the year, and with most of the members on several occasions, since the annual meeting of the Royal Society of Canada and the meetings of the Executive of the Fifth Pacific Science Congress with sectional chairmen, have provided more opportunities than usual. Frequent meetings occur with two or more members in British Columbia.

As in the previous year, the work of the committee has been chiefly concerned with planning co-operation in the attack on oceanographic problems of the west coast of North America with the Biological Board of Canada, the science departments of the University of British Columbia and the Pacific Committee on Oceanography in the United States.

The work and the personnel of the associate committee, the Biological Board and the University of British Columbia, are to such an extent interlocking, that it is impossible to assign the part that each takes, as far as the oceanography of British Columbia is concerned, but the associate committee acts for the three bodies in relation to the Pacific coast of the United States or other parts of the Pacific.

The co-operation with the oceanographers of the United States has been greater this past year than ever before. Dr. T. Wayland Vaughan, Chairman of the U.S. Pacific Committee, who is also International Chairman of the Pacific Science Congress Committee on Oceanography, has spared no pains in keeping everyone concerned posted on the progress of the work. In June, Dr. A. H. Hutchinson represented the committee at a conference on oceanography at Pasadena, and while in California took the opportunity to visit Scripps and other institutions engaged in oceanographic work to discuss ways and means of getting better results.

The chairman spent nine weeks of the summer at the Oceanographic Laboratories of the University of Washington, at Friday Harbor, where a change of policy to engage in a greater amount of research work has been inaugurated. He had opportunity to become fully conversant with the work done and with the plans for future work at the station. During that time two other members of the committee also visited Friday Harbor.

During the later part of the year, Dr. Clemens spent a couple of months at Stanford University, where he came in contact with men in several of the institutions in the San Francisco bay region.

Thus opportunities for interchange of ideas between the co-operating organizations along the whole coast have been turned to greater advantage, during 1931, than ever before.

This activity has been of great value in the preparation of the program in oceanography for the Fifth Pacific Science Congress. If the congress had been held in 1932, as was originally planned, the west coast oceanographers would have been able to show a large measure of accomplishment; with a year's postponement there will be time for more extended investigation and observation, although the decrease in available funds has brought about some considerable curtailment of the research program.

As far as British Columbia is concerned, the most important oceanographic projects are still the study of the conditions in the southeastern portion of the Strait of Georgia, and the comparison of fiord conditions.

Much has been accomplished by the staff of the station at Nanaimo towards an understanding of the physical, chemical and planktonic conditions of the strait. The phosphates received special attention during the year 1931; nitrates and nitrites are now being more extensively determined.

The fiord investigation has proved of great interest and profit. While the three fiords first systematically examined are still receiving the major attention, other fiords along the coast are being investigated to see how they compare with any one of these three.

The various problems of fisheries technology that seem the most urgent are being attacked by the staff at the Prince Rupert Station. Excellent results are being obtained, some of which are of great importance commercially.

The Meteorological Service of Canada is receiving much information of value as to temperatures and circulation in the open ocean.

Associate Committee on Patents and Awards

To the Associate Committee on Patents and Awards the National Research Council has assigned responsibility for the preparation of recommendations on all matters relating to Section 11 of the Research Council Act dealing with patents. In view of the rapid expansion of the Council's work of an industrial character, the question of patents is becoming of ever increasing importance.

Two meetings of the associate committee have been held during the year. Careful consideration has been given to the procedure followed in other countries in respect to patents and it has been learned that practices vary widely, different departments of a single government frequently proceeding in an entirely different manner. In many countries so few patents have been granted to government employees that each case is considered on its merits as the occasion arises. While no two cases are exactly alike, however, it is obviously desirable to lay down certain general principles which may guide the Council in dealing with such matters. This the Associate Committee on Patents and Awards has endeavored to do.

In order to facilitate its work the committee recommended the formation, in each professional division of the National Research Laboratories, of a Subcommittee on Patents and Awards, the first duty of which should be to decide when patents should be applied for on any invention and in what countries they should be taken out. The Council has approved this recommendation of the committee and subcommittees have now been formed and are in operation. Some 15 or 20 patents have been applied for during the year under review. The ownership of all these patents is wholly vested in the National Research Council, except in the case of those covering inventions made in researches supported financially by industrial firms. Under the Research Council Act the exploitation of inventions made by the members of the Council's staff is subject to the control of the Governor in Council.

Associate Committee on Radio Research

Co-operating organizations:

Department of National Defence
Radio Branch, Department of Marine

Following the committee's recommendation to appoint a man to undertake radio researches, the National Research Council secured the services of

Lt.-Col. W. A. Steel. Col. Steel has already organized his laboratory in temporary quarters and it is expected that this work will be transferred to permanent quarters in the new building in the course of a few months.

Through the co-operation of the Royal Canadian Corps of Signals, Department of National Defence, a standard frequency assembly was secured and erected in the laboratory. The necessary equipment was set up to check the frequency of the quartz crystal bar against time signals and standard radio transmissions, and a study has been made during the past six months of the variation of this crystal with time.

It was found possible to hold the frequency constant to three parts in ten million over periods of a month at a time. This is the upper limit of accuracy of the standard transmissions from Washington, and before further progress can be made it will be necessary to set up a number of these individual standards so that they can be checked one against the other under constant temperature conditions.

The Radio Branch of the Department of Marine has secured a similar standard and has installed it in a frequency monitoring station in Ottawa. This station is equipped to check stations in eastern North America over the entire commercial frequency spectrum.

At a special meeting of the Radio Research Committee held on January 6, 1932, it was decided to undertake measurements on the height of the Heaviside layer and on signal fading during the time of the total eclipse of the sun in August of this year. McGill University and the National Research Council will carry out the Heaviside layer work while the Northern Electric Company and the Canadian Marconi Company will undertake the fading measurements.

For the ionized layer work, cathode ray oscillographs and portable transmitters will be employed, one group studying the lower or 100 kilometer layer and the other the 220 kilometer or F layer. The signal fading will be observed by taking actual field strength measurements in the short wave and broadcast bands.

In co-operation with the Radio Research Board in England, the National Research Council has undertaken a study of atmospheric conditions in Canada. One complete set of apparatus as used in England has been secured and is now being set up in Ottawa. This equipment consists of two distinct parts, an atmospheric recorder and a cathode ray direction finder for atmospherics. It is hoped to co-ordinate this work with similar experiments being carried out at Slough in England and by the American Telephone and Telegraph Company at Houlton, Maine.

Associate Committee on Trail Smelter Smoke

Co-operating organization:

Federal Department of Agriculture

Continuing on behalf of the Dominion Government its investigation of the effect of sulphur dioxide on vegetation in the vicinity of Northport, Washington, the committee has continued an automatic record of sulphur dioxide concentration at two points in the Columbia Valley, one of these being a few miles above Northport and the other at the village of Marble farther down the valley. By means of these records readings of sulphur dioxide concentration in the atmosphere have been taken at intervals of twenty minutes continuously since 1929.

Observations have been continued on the effect of sulphur dioxide on vegetation at all points south of the international boundary where there was any possibility of damage being done. These observations have been accompanied by sampling of the needles of conifers and of other vegetation. Samples taken have been analyzed for sulphur to detect any abnormal accumulation of this element.

The elaborate fumigation tests at Summerland, B.C., to which reference was made in the last annual report, have now been completed. In view of the fact that the recommendations of the International Joint Commission for the settlement of the case have not yet been acted upon by the Canadian and American Governments, it is not possible to make public the results obtained. Reports are being prepared, however, and it is expected that the results will eventually prove of the greatest interest, showing in an unmistakable manner the effect of the various factors in causing injury to vegetation.

Associate Committee on Tuberculosis

Co-operating organizations:

Federal Department of Agriculture
Fort Qu'Appelle Sanatorium
Queen Alexandra Sanatorium
Queen's University
Sun Life Assurance Company of Canada
University of Alberta
University of Montreal
University of Toronto

The sixth meeting of the committee was held in Ottawa, March 11-12, 1932. Reports were presented covering the researches in progress under the committee and plans were discussed for future work.

As at previous meetings the chief interest of the committee centered in vaccination with a vaccine developed by Calmette and Guérin of the Pasteur Institute of Paris. This vaccine (B.C.G.) has been subjected to experimental work by several research workers under the committee and in the light of the reports presented the committee considered whether any changes should be made in its tentative findings as outlined on pages 93-94 of the previous annual report. No radical changes were made, although it was the consensus of opinion that recent information made available both through the committee and other investigators had materially strengthened the evidence of the innocuity of B.C.G. Members of the committee did not consider that there was danger of the reversion of B.C.G. to a virulent form in the tissues. It was agreed that an effort should be made to secure definite information on the difficult question of the duration of the increased resistance conferred by B.C.G.

Dr. MacMurchy called attention to the need of more information regarding tuberculosis amongst the Eskimos. The matter is of special concern to the Federal Department of Health since the Eskimos are not under the jurisdiction of any of the provinces.

The committee gave consideration to the "clean-herd" plan of the Federal Department of Agriculture and to the institution of tuberculosis-free areas and recommended to the department that for the present these areas be actively maintained and kept under supervision.

After a full discussion of the value of the pasteurization of milk it was moved by Dr. FitzGerald, seconded by Dr. Hilton and unanimously resolved

that the Associate Committee on Tuberculosis Research of the National Research Council go on record as strongly endorsing the adequate pasteurization of all public milk supplies as essential for the control of milk-borne infection, including bovine tuberculosis.

Tuberculosis Research of the Federal Department of Agriculture

No written statement has been submitted to the committee by the Federal Department of Agriculture on the tuberculosis researches being carried out by the department at the Animal Diseases Research Institute and elsewhere, but Dr. Mitchell reported verbally that work was actively under way. In one investigation Dr. Watson is studying the possibility of the reversion of B.C.G. to a virulent form in the tissues, using for the purpose a group of animals completely isolated. The results of this investigation will be reported later. Work is being continued on avian tuberculosis.

(Investigation under the direction of Dr. E. A. Watson.)

Tuberculosis Research at the Fort Qu'Appelle Sanatorium

The tuberculosis death rate amongst the Indians under observation during the past year has been 279 per 100,000, the lowest since records have been kept during a period of nearly 50 years, and a reduction of 70% in the last five years. The need for further work is nevertheless evident, as shown by the fact that this death rate is still approximately six times that of the white population of the surrounding territory.

During the year a special study has been made of sources of infection amongst school children. The faeces of healthy tuberculin sensitive children having no demonstrable tuberculous lesions did not produce tuberculosis in experimental animals. In the cases of children having definite lung lesions and those having a persistent cough a considerable proportion of the faeces showed the presence of tubercle bacilli. The urine gave a positive test for tuberculosis in a smaller proportion of the cases. This study will be continued and it is hoped that in another year definite evidence will be available showing exactly what types of cases should be permitted to remain in the schools.

Throughout the year excellent medical services have been given the Indians by Dr. A. B. Simes. All cases with tuberculous lesions have been under observation and those requiring it have received hospital treatment. All school children have been checked regularly and 466 have been X-rayed.

(Investigation under the direction of Dr. R. G. Ferguson.)

Tuberculosis Research at the Queen Alexandra Sanatorium

Important laboratory expansion at the Queen Alexandra Sanatorium has taken place during the year. Through the generosity of Mr. W. L. Mara a new block of laboratories, to be known as the Mara Research Laboratories, has been constructed and will shortly be put in operation. These laboratories contain a large X-ray room, five smaller research laboratories, and a large machine shop. Special equipment is also being provided.

As previously, the year's work has been continued along two main lines, including biochemical investigations and X-ray studies. Further work has also been done on the false complement fixation reaction reported last year.

From the experimental work it now appears that tuberculo-complement fixation is a function of a physical state of the antigen particles and will result from this physical state whether induced by immune serum or by artificial chemical or physical means.

The basic aim of the X-ray studies has been to increase the knowledge of the clinical state of a patient with special reference to the differential diagnosis of pulmonary tuberculosis. Clinical and pathological facts have been correlated with observed X-ray film shadows. In this work X-ray technique is exceedingly important and the development of improved technique has therefore received much attention. New designs of X-ray tubes have been tested and their chief features have been analyzed. Several papers have been published during the year dealing with X-ray questions of interest to radiologists.

(Investigation under the direction of Dr. F. H. Pratten.)

Tuberculosis Research at Queen's University

During the past year attacks have been made upon various phases of the problem of the variability of the tubercle bacillus. A study has been made of acid agglutination and electrophoretic potentials. The antigenic activity of S and R cultures has been measured by complement fixation methods and studies have been continued on the dissociation of B.C.G. cultures. (S colonies are usually smooth in form and virulent; R colonies rough and avirulent.) A preliminary report has been prepared on the progress of tuberculosis in man, as determined by colony form of the causal organisms complement-fixation with standard S and R antigens. Further work has also been done on the dissociation of *Mycob. leprae* and other acid-fast organisms.

Previous work has indicated that various species of acid-fast bacteria may be separated into S and R types and that these differ in respect to the surface potential charge of the individual organism. It has now been shown that S and R types of *Mycob. leprae* suspended in distilled water show a difference in electrophoretic potential of approximately five times the probable error of the determination. One paper on this subject is in press.

The S types of human, bovine and avian tubercle bacilli and also of *Mycob. leprae* have been found to contain antigenic substances not present in the R type of the same strain, dissociation seemingly being accompanied by a considerable loss in antigenic complexity. Immune sera prepared against such S organisms contain three types of antibodies—those reacting with extracts of the homologous S organisms, but not with the homologous R type; other antibodies reacting with both S and R of the same species; and a third type of antibody detected by antigens prepared by the other species of acid-fast bacteria that is a group antibody. Antisera prepared against R organisms, on the other hand, appear to lack the S-specific antibody which is found in S antiserum, but contain a much higher proportion of antibodies reacting with extracts prepared from other acid-fast species.

Of five cultures of B.C.G. received from various sources four were found to consist entirely of R types, while the fifth, not coming directly from the Pasteur Institute, contained a few S types. All five cultures when cultivated for periods up to about two years, on media differing radically from that recommended by Calmette, and under conditions not found in the animal tissues, dissociated into R and S types, the latter of which proved virulent to guinea pigs. By means of complement-fixation reactions it was shown that the S form recovered from B.C.G. cultures, like the typical S tubercle bacillus,

contains a specific antigenic substance which is lacking in the ordinary B.C.G. and other R forms of the species. Animals immunized with S organisms have been shown to develop a specific S antibody which is lacking in the serum of animals treated with R organisms, such as B.C.G.

In a preliminary study it has been shown that primary plate cultures from sputum of pulmonary tuberculosis cases frequently show S colony types, very rarely R colonies, and frequently mixtures of intermediate forms. The form of these colonies resembles well established S, R and intermediate strains of tubercle bacilli. Notwithstanding the impossibility at present of definite differentiation on the basis of colony form, it appears in the cases examined that the severity or chronicity of the case is correlated with the colony form in the cultures. It has been further shown in a study of 110 cases of tuberculosis that antigens prepared from a definite S type of tubercle bacillus have given very different complement-fixation reactions from those prepared from an equally definite R type. This study is being continued.

Many cultures of *Mycob. leprae* have been examined and have revealed two or more colony types. Some were exclusively S, others exclusively R, and a third group mixtures of the two with intermediate forms. On most media both S and R types have shown stability, but in certain culture fluids dissociation from S to R has occurred quite regularly, while the reverse dissociation, though also taking place, has been much less common.

Several research papers giving details of the above experiments have already been published and others will appear shortly.

(Investigation under the direction of Dr. G. B. Reed.)

Tuberculosis Research at the University of Alberta

The vaccination of tuberculous herds under observation has been continued and a more efficient control has been worked out. In the Ponoka herd there are now 95 animals fully vaccinated and revaccinated. These animals have been in contact with tuberculous animals from birth and have received from birth unpasteurized milk.

It is now proposed to change the method of primary vaccination, which up to the present time has been subcutaneous, to that of a double vaccination, intravenous and subcutaneous at the same time, and to separate the young calves from the herd for a period of at least one month during which they are fed on pasteurized milk. The object of the double vaccination is to try to produce a more rapid resistance in certain tissues than can apparently be produced by the subcutaneous method alone.

In 1930 a report was presented on the milk of 29 vaccinated cows which had been in contact with tuberculous animals since birth. Six of these gave a positive test but only one of the six cows had been regularly revaccinated. Of 151 controls 39 were positive. Twelve of the 29 animals reported on in 1930 have now come to autopsy. Of these only one had generalized tuberculosis.

For experimental purposes 90 additional tuberculin-tested animals have since been secured. Of these, 50 have already been vaccinated by the double method, while the remainder have been reserved as controls. These animals have all been acquired from tuberculosis-free herds, have been fed on pasteurized milk, and have been kept strictly isolated from tubercular animals.

(Investigation under the direction of Dr. A. Rankin.)

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Tuberculosis Research at the University of Montreal

As previously, the chief work of the Montreal group has been the vaccination of babies with B.C.G. and the careful observation of both the vaccinated children and a large number of controls. The number of children vaccinated during 1931 is 285, bringing the total vaccinated children to 2,166. The distribution of B.C.G. has been made through the School of Public Health Nursing of the University of Montreal.

The present report covers the detailed record of 741 children, of whom 341 were vaccinated and 400 were unvaccinated controls. Both the mortality and morbidity of the two groups have been studied.

The general mortality of the vaccinated children during a period of four years has been 117 per thousand against 140 for the controls, a difference in favor of the vaccinated children of 16%. The mortality from tuberculosis of those in contact with positive sputum cases was 63% less in the case of those vaccinated. In a group of 33 vaccinated babies from one to twelve months old in contact with positive sputum cases the deaths from tuberculosis were 92% less than in the unvaccinated controls. The morbidity of the vaccinated children is also considerably less than that of the controls, particularly in respect to tuberculosis, where the margin is 84% in favor of the vaccinated children. These figures indicate that a very appreciable protection of children against tuberculosis is conferred by vaccination with B.C.G.

Further, the innocuity of B.C.G. is regarded as fully established, no untoward effect having been observed from the vaccination of 2,166 children who have been under observation over a period of five years. The innocuity of B.C.G. has been confirmed by the repeated inoculation of massive doses of B.C.G. into guinea pigs, which are still alive and well after having been kept under close observation over a long period of time.

(Investigation under the direction of Dr. J. A. Baudouin.)

Tuberculosis Research at the University of Toronto

During the year under review an investigation has been continued on the types of tubercle bacilli in human tuberculosis and on the influence of silica upon the growth of tubercle bacilli. There has also been carried out a study of the possible relation of tuberculosis to Hodgkin's disease.

Four hundred and thirty-six cases of clinical tuberculosis were investigated with a view to ascertaining the types of the infecting organism. In this series of cases, 268 were children under 14 years of age, and 168 adults, 15 years and over. Both medical and surgical cases were studied. In the juvenile group, 230 patients proved to be infected with the human type, and 38, or 14.1%, with the bovine type of tubercle bacillus. In the adult group 6, or 3.5%, proved to be infected with the bovine type, the remaining 162 cases with the human type of tubercle bacillus.

Of particular interest among the new cases of bovine tuberculosis encountered are three from Kirkland Lake, Ontario. Two of these came to Toronto prior to the outbreak of the epidemic of septic sore throat in that community, while the third case appeared shortly following the epidemic. In the latter part of December, 1930, there occurred in Kirkland Lake a severe outbreak of septic sore throat, the source of which was finally traced to one dairy. Seven head of cattle from the infected dairy were slaughtered, and although these animals were presumably tuberculin negative and belonged to an accredited herd, one of the seven animals was so grossly infected

with tuberculosis that the carcass was condemned. Subsequent to this epidemic the sale of raw milk was prohibited and a compulsory pasteurization by-law was passed.

The effective pasteurization of milk appears to be the only solution for the prevention of bovine infection. Pasteurization, however, can be considered safe only when carried out under rigid control. The excellent results obtained in Toronto from the standpoint of the eradication of bovine tuberculosis are attributable mainly to the efficient pasteurization of milk, and afford an effective demonstration of the control of bovine tuberculosis in man.

Preliminary results of an investigation on the influence of silica on the growth of the tubercle bacillus were published in the fourteenth annual report. These results have now been further confirmed. The effect of silica appears to be roughly in proportion to the solubility of the compound containing it. Thus, it has been found that the addition of small amounts of sodium silicate causes the greatest stimulation and quartz suspensions the least.

The cause of Hodgkin's disease is obscure. Clinically this common and fatal disease appears more like an infectious process than a primary disease of the blood-forming organs, while the gross character suggests the presence of an invasive tumor. Some have considered it an atypical form of avian tuberculosis.

Five cases of clinically and histologically typical cases of this disease were investigated with a view to determining any possible association with avian tubercle bacilli. In each case a lymph gland was removed by an operation and was inoculated into fowls, and also into rabbits, which are extremely susceptible to avian tuberculosis, usually dying within three weeks of a generalized infection. In no case did avian tuberculosis develop. In the case of two guinea pigs inoculated in the same way tuberculosis of a human type was contracted.

The results of all these studies will shortly be published in the Canadian Journal of Research.

(Investigation under the direction of Dr. Oskar Klotz.)

Associate Committee on Weed Control

Co-operating organizations:

Alberta Department of Agriculture
Federal Department of Agriculture
Manitoba Department of Agriculture
Saskatchewan Department of Agriculture
University of Alberta
University of Manitoba
University of Saskatchewan

The third annual meeting of the Associate Committee on Weed Control was held at Edmonton, January 21 and 22, 1932. The reports received from the various co-operators are summarized below. Many of these will appear in due course in a series of scientific papers to be sponsored by the committee. It was decided to publish immediately Mr. Manson's report of the weed survey, with maps, and a popular bulletin discussing weed control in the light of the committee's findings to date.

A meeting of the Subcommittee on Chemical Experiments was held on the evening of January 21, at which the plan of field experimentation for 1932 was discussed and agreed upon.

Weed Investigations by the Federal Department of Agriculture

The Dominion Department of Agriculture is carrying on a number of investigations on the use of cultural practices, rotations and chemical eradicants for the control of weeds. A sub-station has been established at Regina, where such problems as the best stages of chemical treatment, the effect of mowing perennials previous to treatment, depth to which chemicals kill roots, and the number and viability of weed seeds in the soil, are being investigated.

The Brandon Experimental Farm has co-operated with provincial agencies in the weed control program in Manitoba, notably on the eradication of couch grass by cultivation and chemicals, on the control of stinkweed by chemicals, and of wild oats by cultivation.

The Division of Botany is carrying on a systematic survey of a large number of wild plants, including weeds, which in time should provide a very good picture of their distribution throughout the whole country. It has not so far covered the prairie provinces.

The Seed Branch is investigating the seed population of soils under different conditions of cultivation.

The Dominion Chemist has supplied the committee with analyses of a large number of commercial herbicides.

Weed Investigations by the Alberta Department of Agriculture

Sulphuric acid was found the most effective herbicide for stinkweed in wheat, although more concentrated solutions were required than in 1930. Solutions of 7 and 12% by weight, applied at rates of 100 and 50 gal. per acre respectively, gave complete control. Of the chemicals tested copper nitrate was the most injurious to the crop. Copper sulphate was satisfactory only when used in relatively large amounts and iron sulphate and sodium chlorate were unsatisfactory for this annual weed.

Where weeds were controlled by chemical treatment in alfalfa fields, the crop suffered severe damage.

Light infestations of stinkweed should be treated when, or before, the crop is in the three-leaf stage. Heavy infestations may be successfully treated later.

Ammonium sulphate and sodium chloride did not control Canada thistle and sodium dichromate and sodium bisulphate were ineffective against sow thistle. Treatments of Canada thistle and couch grass with sodium chlorate at the flowering stage were most effective.

(Investigations under the direction of Messrs. E. L. Gray and W. G. Smith.)

Weed Investigations by the Manitoba Department of Agriculture

Two hundred gallons per acre of 5% solution of sulphuric acid procured complete control of stinkweed with but slight damage to the crop. The sterilizing effect on soils of chemicals used for control of perennials appears to affect weeds less than crop plants on Red River Valley soils, weeds becoming re-established before crop production would be profitable. Experiments showed that wild oat germination in soil increases to a depth of four inches and then decreases and that very low germination occurs at ten inches. Weed seeds in silage lost their viability rapidly.

A study of weed distribution in Manitoba, with special reference to introductions, and experiments on the control of two of the most recent of these, hoary cress and leafy spurge, are being carried on.

Data show that weeds vary in their power to reduce crop yield, sow thistle in one case reducing yield by 57%, while red root pigweed caused a reduction of 8.3% under similar conditions.

Records of the diseases of weeds in Manitoba are being compiled.

(Investigations under the direction of Mr. Geo. Batho and Dr. G. P. McRostie.)

Weed Investigations by the Saskatchewan Department of Agriculture

Of the annual weeds, wild mustard and stinkweed were the most easily controlled by chemicals, and cereals were more resistant to chemicals than other crops tested. Sulphuric acid, sodium chlorate, copper sulphate, iron sulphate and sodium chloride were effective on wild mustard, but only sulphuric acid controlled stinkweed. Beneficial results were not obtained when the crops treated had suffered previous damage from drought or soil drifting. Heavy applications of copper sulphate did not injure the soil for crop production.

Sodium chlorate was the most effective chemical for the control of perennials, but its use involved the destruction of any crop present and left the soil barren for at least two years. Perennial weeds vary in their resistance to sodium chlorate. Poverty weed control demands a minimum of 0.75 lb. per 100 sq. ft., while for perennial sow thistle, Canada thistle and couch grass the minima are respectively 1, 1.5 and 2 lb. per 100 sq. ft. Weather conditions, particularly rainfall, influenced the results obtained in perennial weed control experiments. In areas of heavy infestation, black summerfallow is easily reinfested by sow thistle seedlings.

A comprehensive experiment on control of poverty weed by tillage is under way at Eston, Saskatchewan.

(Investigations under the direction of Messrs. S. H. Vigor and G. Godel.)

Weed Investigations at the University of Alberta

A widespread disease of ball mustard, caused by *Cercosporella nesliae*, reduces the vigor and seed yield of infected plants. There is no evidence that the organism affects other weeds or crop plants.

All three common foot-rotting organisms of wheat affect couch grass and the presence of this weed appears to increase the persistence and rate of spread of these organisms in the soil.

A smut disease affecting western rye grass also occurs on *Agropyron richardsonii*, a common wild grass. It is possible that other wild species of *Agropyron* and also of *Bromus* may be susceptible to this disease and may act as a source of inoculum for the cultivated species. This is being investigated.

A survey of disease of weeds is being continued and collections made. A number of diseases not previously reported in Canada have been found.

(Investigations under the direction of Dr. A. W. Henry.)

Methods have been developed for the determination of small amounts of chlorates and for ascertaining nitrates in the presence of chlorates in soil. Sulphuric acid and copper sulphate in quantities sufficient for the control of annual weeds did not harm Alberta soils. Leaching played an important part in the distribution and toxicity of sodium chlorate in the soil, heavy rains rendering the surface layer free of any toxic effect. The decomposition of sodium chlorate was promoted by heavy applications of easily decomposed organic matter. Sodium chlorate did not greatly affect nitrification in the soil.

Sodium dichromate decomposed rapidly in the soil but reduced the number of soil micro-organisms and had an adverse effect on nitrification. It was also more toxic to wheat than sodium chlorate.

(Investigations under the direction of Dr. J. D. Newton.)

NOTE: The weed survey of the prairie provinces, by Mr. J. M. Manson, and the experiments with chemicals as herbicides and on fire-hazards in their use, by Dr. W. H. Cook, with headquarters at the University of Alberta, were financed and directed by the National Research Council, and will be found summarized in the Report of the Division of Biology and Agriculture, page 20.

WEED INVESTIGATIONS AT THE UNIVERSITY OF MANITOBA

The very rapid growth of sow thistle roots has been demonstrated, six to seven feet of growth on an individual root by the end of June being not uncommon. Persistent cutting of sow thistle plants caused the current season's roots to develop the abnormal habit of producing flowering stalks. In disked fields, old and apparently decomposed roots produced healthy shoots, and vertical roots appeared a fertile source of reinfestation of fields.

In summerfallowed areas the greater amount of plant energy appears to go into the development of vigorous root growth. The plowing down of a two-year-old sweet clover stubble in the third year after fallow tends to control regrowth of sow thistle from the underground parts unless heavy precipitation occurs.

Shoots from old, deeply buried couch grass roots may reach the surface from considerable depths. Rapid growth of rootstocks was illustrated by one bud from which was grown 270 feet of rootstock between June and October. Investigations into the food reserves of rootstocks of sow thistle and couch grass are in progress.

(Investigation under the direction of Dr. G. P. McRostie.)

WEED INVESTIGATIONS AT THE UNIVERSITY OF SASKATCHEWAN

Root studies showed that the laterals of Canada thistle occur in greater numbers and at greater depths than those of sow thistle. While the lateral

roots of sow thistle spread horizontally to an indefinite distance, those of Canada thistle grow horizontally for some distance and then dip abruptly downwards. The former type of development makes for very rapid spread, the latter for difficulty of eradication. Persistent shallow tillage appears to offer an efficient and economical means of sow thistle control.

Regrowth from the nodes occurred in wild oats. In these and in tame oats, regrowth of the seedling took place from the surface of the soil to one inch below, while in wheat, rye and barley regrowth occurred from nodal tissue close to the seed. At later stages regrowth in wild oats and in the cereals may take place from nodes near the surface and also above ground.

Wild oats germinated most readily in the surface two inches of soil, but some germination was obtained twelve inches below the surface. Plants from deeply set seeds produced one or more sets of secondary roots, the number of these depending upon the depth of planting.

The root system of wild oats develops more slowly in the early stages than do those of the cultivated cereals, but at maturity the wild oat has a greater mass of more deeply penetrating and more profusely branched roots than the cereals.

Applications of sodium chlorate to the soil, or to the tops only, gave poorer results than applications to both soil and the tops of perennial weeds. Watering the soil a few days after the application of the chemical increased the efficiency of the treatment.

Ethylene and propylene oxides injected into the soil were effective eradicants of dandelion and pasture thistle when amounts of 5 to 7 cc. per plant were used. These chemicals killed all roots of Canada thistle, sow thistle and toad flax within six inches of the point of application. With gasoline, 10 cc. per plant failed to kill dandelions.

(Investigations under the direction of Dr. L. E. Kirk.)

Associate Committee on Wool

Co-operating organizations:

Canadian Co-operative Wool Growers
Canadian Woollen and Knit Goods Manufacturers' Association
Dominion Department of Agriculture
University of Alberta
University of Saskatchewan
Wool Industries Research Association (Great Britain)

Three meetings have been held under the auspices of the committee,—a meeting of the Wool Growing Section at Guelph on June 22, 1931, in connection with the annual meeting of the Canadian Society of Technical Agriculturists, a meeting of the Manufacturers' Section in Toronto on November 24, and the annual meeting of the full committee in Toronto on November 25 at the time of the Royal Winter Fair.

Dr. W. H. Fairfield has now continued for 12 years at the Lethbridge Experimental Station his crossbreeding experiments with Corriedale sheep, his work being done entirely at the expense of the Dominion Department of Agriculture. A purebred flock of Corriedales is being maintained and grade Corriedale rams have been used on a large flock of grade Rambouillet ewes in order to determine the value of this cross. It appears that the infusion of Corriedale blood will result in an improvement in mutton conformation and at the same time a more valuable crop of wool.

Under a committee consisting of Dr. Fairfield, Prof. Sackville of Edmonton, and Dean Shaw of Saskatoon, a mass breeding experiment is being con-

ducted at Cardston, Alberta, a direct comparison being made between a Corriedale-Rambouillet cross and straight Rambouillet breeding with the same type of ewes, the work being done in co-operation with Mr. Nielson, a prominent rancher. The lambs of the Corriedale-Rambouillet cross have proved distinctly superior to the Rambouillet lambs but no wool is yet available for test. The cross is regarded by the committee as a very promising one.

Wool-growing experiments at the University of Alberta under Prof. Sackville are designed to show the effect of variations in environmental factors on the quality of wool. Eight groups of sheep are being subjected to varying conditions of temperature, humidity and nutrition, with variations in the time of shearing. The nutrition experiments include high, medium and low planes of nutrition and variations in protein and minerals. The wool produced is being tested in the National Research Laboratories. An outline of this work will be found on page 28, under the report of the Division of Chemistry.

Experiments being conducted by Dean Shaw at the University of Saskatchewan consist in crossing range ewes with rams of the English Leicester, Cheviot, Corriedale and Ryeland breeds. The Ryelands constitute the first importation of this breed into Canada. The wool of the lamb crop has not yet been studied in detail, but the lambs of the Ryeland and Corriedale crosses show greatly improved mutton conformation and will undoubtedly produce a good grade of wool also. The Romney breed has already been discarded as unsatisfactory for growth under range conditions when crossed with range ewes.

At a meeting of the Manufacturers' Section Dr. Zeidler gave an account of a recent trip to Europe. He described general conditions prevailing there and referred in particular to those affecting the textile industry and textile research. Specific problems were outlined.

The manufacturers also discussed the advisability of the National Research Council undertaking a large program of research on fundamental problems of wool manufacture. No definite recommendation was made, but it was the consensus of opinion that there was ample room for work by both the National Research Council and the Ontario Research Foundation. It was suggested that these organizations should have further consultations on matters of mutual interest. The committee requested the Canadian Woollen and Knit Goods Manufacturers' Association to consider the relation of this association to the research organizations and to inform the National Research Council what type of problems on wool manufacture they wished to have carried out by the Council.

The committee has undertaken a further study of wool statistics, which are regarded as quite inadequate for the purpose of both growers and manufacturers. A special committee, consisting of Dr. Tory, Major Hallam and Mr. Panabaker, was appointed to deal with this question.

Two other subcommittees were also appointed. One, consisting of Dr. Whitby as chairman and Messrs. Larose, Sackville and Shaw, was requested to make a detailed study of the results of experiments at the University of Alberta and of the tests made at the National Research Laboratories on wool produced in these experiments. The other subcommittee, on special grading tests, consists of Mr. Tisdale as chairman and Messrs. MacMillan, Panabaker and Whitby. This subcommittee has been asked to make arrangements for special grading of all experimental fleeces, for a comparison between Canadian and imported wools, and if possible for manufacturing tests on certain wools of special interest to the committee.

SPECIAL COMMITTEES

Executive Committee on the Fifth Pacific Science Congress

During 1931-32, arrangements for the scientific program of the Fifth Pacific Science Congress were practically completed and upwards of 600 distinguished scientists from the countries bordering on the Pacific ocean and from Europe were invited to contribute papers on specified subjects for presentation in one or other of the sixteen sections in which the Congress is being organized. These sections represent every important branch of the biological and physical sciences in which research work relating to the countries of the Pacific basin is being carried on.

Through the Congress papers and discussions it is expected that a substantial contribution will be made to the sum of human knowledge of the scientific aspects of life in the Pacific area.

Early in the year and soon after His Excellency, the Earl of Bessborough, had taken office as Governor-General of Canada, the President of the Congress was informed that His Excellency had graciously consented to act as Patron of the Congress, thus continuing the vice-regal honor conferred by Lord Willingdon during his term of office.

In May, 1931, a meeting of the executive committee of the Congress was held in Toronto when further consideration was given to the organization of the subjects selected for symposium discussion, both before the Congress as a whole and also in the two main divisions.

For the general Congress symposia on recent advances in the application of science to industry, and on fiords of the Pacific, general invitations were extended to member institutions to arrange for contributions relevant to their respective countries. Selected distinguished scientists in each field of study will be asked to review the material in these papers and to present at the Congress a concise summary of the data.

Problems of air and water circulation have been assigned to representative officials in the various countries for study and report, and it is expected that the views of the contributing hydrographers, meteorologists and oceanographers will enable the members of the Congress to obtain a conspectus of the attainments and to appraise the needs in this field, which is of the greatest importance to navigators. The results of studies made by such men as Commander P. M. van Riel of the Royal Netherlands Meteorological Institute, who recently returned from a lengthy sojourn in the southern Pacific, will be presented to the Congress in this symposium.

Speakers have also been selected to discuss the much argued question of the origin of the American aborigines. Dr. Alës Hrdlicka, internationally famous investigator, and curator of the division of physical anthropology in the Smithsonian Institution, will review the orthodox opinion on this perplexing problem.

In the two main divisions of the Congress, similar arrangements have been made for the six symposia meetings. Contributions from member institutions have been invited, and the papers submitted will be summarized by competent authorities on the several subjects. Where necessary, supplementary papers will be read by leading exponents of the subject so that the treatment in each case will be comprehensive and authoritative.

During the summer months, the work of preparing the detailed programs was pressed forward vigorously with the result that a preliminary list of papers and authors was completed and issued in bulletin form to Congress officials and committee members.

In October, because of the continuing depression in business the world over, and as a result of representations made by several member institutions, the Government of Canada announced the postponement of the Congress for one year in the hope that the general economic situation in 1933 would be so improved that the Congress might then be held under more auspicious circumstances than seemed likely to prevail in 1932.

Member institutions and authors of papers were advised at once of the decision, but they were asked to continue preparatory work for the Congress so that there would be no loss of effort because of postponement.

Further meetings of the executive committee were called at once to consolidate the work that had been done, and to arrange for the continuance during the postponement period of all necessary preparations for the Congress.

To this end, eastern members gathered at Ottawa in December, and the western members assembled in Vancouver in January. It appeared to be the consensus of opinion among Congress officials that the postponement was a wise step and it was pointed out that the additional year would enable authors of papers to make wider studies and to consider much new material that would not have been available to them for the meeting in 1932.

An interesting feature of the discussion at the last meeting of the executive committee was the consideration of a letter from one of the leading scientists in the U.S.S.R., in which assurance was given that a strong delegation would be sent from that country to Canada on the occasion of the Congress. In this letter also the organization of research in countries bordering on the Pacific ocean was discussed, and it was suggested that a comprehensive plan might be prepared by which each country would undertake to carry out a definite program of research on Pacific problems. Under such a scheme, the Pacific Science Congress meetings of the future would function chiefly as clearing-houses for proposals and reports relating to scientific investigations of interest to all countries in this area.

A consolidated index of the titles of papers and the names of authors found in the proceedings of the first four Congresses (Hawaii, Australia, Japan, Netherlands Indies) is in course of preparation and will be published in connection with the proceedings of the Fifth Congress.

Of the countries invited to the Congress, four have already named their delegates—France, Hong Kong, Siam, and the Soviet Union. Seven others (Australia, China, Ecuador, Japan, Mexico, New Zealand and United States) have appointed national committees to arrange for the appointment of delegates and for the preparation of contributions to the Congress program. In the United States, the National Research Council in Washington has drawn the Congress to the attention of 207 scientific institutions in that country and of 454 of their outstanding men of science. This indicates that when the time to hold the next Congress is considered opportune, the visitors and delegates who will come to Canada on that occasion will represent the best scientific thought on matters relating to the Pacific area. Obviously, the results of such a Congress are likely to be of vast importance and far-reaching in their effects.

Special Committee on Electrical Units and Regulations

Co-operating organization:

Electricity and Gas Inspection Service

In submitting its second report to the Council, the committee advocated that the Council specify and define the units for the measurement of electrical quantities which the committee had previously studied. The list of these units was given in the committee's report for 1930-31. These recommendations were subsequently adopted.

Mr. A. J. Grant was appointed to the laboratory staff to take charge of electrical measurements and has begun the organization of a laboratory for standardization. When the staff moves into its new quarters, it is expected that the laboratory will be rapidly established. On the committee's recommendation the Council will purchase the following standards and equipment to be used in the standardization laboratory:—

1. Seven standards of resistance ranging in value from 1 to 10,000 ohms.
2. Three standards of resistance with high current capacity ranging from 0.0001 to 0.1 ohm.
3. Four standards of inductance ranging in value from 1 to 10 millihenries.

For secondary comparisons the following instruments were purchased:—

1. A Brooks deflection potentiometer with a complement of volt multipliers and shunts.
2. A laboratory standard a.c. voltmeter with six ranges up to 750 volts.
3. A laboratory standard combination ammeter and wattmeter for alternating currents with a current capacity up to 10 amperes and voltage ranges up to 750 volts.
4. A laboratory standard d.c. millivoltmeter with ranges up to 200 millivolts and accompanied by shunts suitable for measuring currents up to 100 amperes.

In making these recommendations the committee took into consideration the fact that the Council already possessed a number of standards and instruments, including a precision potentiometer, a volt box and saturated standard cells with oil bath and temperature control. While it is recognized that this equipment does not comprise all the apparatus necessary for a properly equipped standards laboratory, the committee felt that a more complete installation could not be effectively employed at this time owing to limited staff and facilities. In any case the above equipment should be sufficient for most comparisons which the laboratory would be called upon to make in the immediate future. In addition to this equipment, the laboratory also purchased a precision Kelvin double bridge which may be used for measuring low resistances and may also be employed as a Hoopes conductivity bridge.

In view of the Council's responsibility in connection with the approval of the types of electricity meters, the committee has prepared a set of specifications for this approval after having consulted manufacturers' representatives and also the C.E.S.A. Meter Committee group. These specifications will shortly be submitted to the Council.

SUMMARY OF REPORTS ON ASSISTED RESEARCHES

Each recipient of a grant from the National Research Council is required to submit annually a report of the progress of the research work being carried out under his direction. Summaries of such reports will be found below. In addition, the Council has published during the year in the Canadian Journal of Research scientific papers giving the detailed results of many such investigations. References to other recently published papers will be found at the end of a number of the summaries.

A list of research grants made by the Council from the beginning of its work is given in Appendix B, page 136.

Those of the grants made through associate committees are summarized under the committee reports, beginning on page 62.

The Action of Alkali Water on Cement and Concrete

Co-operating organizations:

Canada Cement Company
Canadian Pacific Railway
City of Winnipeg
Engineering Institute of Canada
Province of Alberta
Province of Saskatchewan
University of Saskatchewan

This investigation has been under way for the past 11 years, and brief statements regarding the progress made have appeared in the Council's annual reports issued during that period. Since, however, the work is now being brought to a successful conclusion, and commercial application is being made of the results obtained, it may be of general interest to outline the investigation from the beginning and to indicate briefly the part taken in it by each of the co-operating organizations. For the sake of those who may wish to study the subject in some detail, reference is made to the many scientific papers in which the results of the investigation have been published.

The attention of the National Research Council was early directed towards the problem of the rapid deterioration of Portland cement concrete when exposed to the action of the so-called "alkali" water prevalent in many parts of western Canada. A survey was carried out to determine the extent of the damage from this cause, and the matter was found to be of sufficient importance to justify immediate action. Having at the time no research laboratories or technical staff of its own the Council brought the matter to the attention of the Engineering Institute of Canada, which at once formed a committee, under the chairmanship of Dean C. J. Mackenzie of the University of Saskatchewan, to make a thorough study of the problem. To this committee the following contributions were made over a period of years:—

Canada Cement Company	$ 11,997
Canadian Pacific Railway	3,000
City of Winnipeg	700
National Research Council	20,000
Province of Alberta	2,000
Province of Saskatchewan	9,000
	$ 46,697

Since 1926 the National Research Council has contributed a further sum of $30,400 towards the chemical researches of Dr. T. Thorvaldson, of the University of Saskatchewan, making a total of $50,400 granted by the Council for this investigation. The Canada Cement Company, while not contributing directly to the work in recent years, has carried out a considerable amount of experimental work on its own plants which has resulted in the commercial manufacture of an alkali-resistant concrete from Canadian raw materials. Further, while the University of Saskatchewan does not appear in the above list as a contributor, its actual contribution in the time of Dr. Thorvaldson, Dean Mackenzie, Prof. G. M. Williams and other members of the staff, and in the university facilities placed at their disposal for this work, has been a very substantial one.

The first step in the investigation was a field study of the action of alkali water on concretes of various mixes. This work was carried out under the immediate supervision of Dean Mackenzie and Prof. Williams. Concrete specimens were exposed in three experimental plots, in Manitoba, Saskatchewan and Alberta respectively. The results of this work indicated that under adverse conditions any concrete, and even specimens of neat cement are subject to disintegration. The resistance of the specimens tested increased with increased richness of mix up to approximately a 1:2 mix, which gave a maximum life. There were found differences in resistance which might be attributed to differences in the cements used or in the treatment of the specimens.

The following reports were published by the committee and associates:—

Title	Author	Publication
A series of papers on "Decay of Concrete in Alkali Soils."	B. Stuart McKenzie A. G. Blackie H. M. Weir A. S. Dawson	Engineering Journal, Aug. and Sept., 1918.
Concrete Mixtures in Alkali Soils.	C. J. Mackenzie	Engineering Journal, April, 1920.
Concrete in Alkali Soils and Waters. Discussion on Western Concrete Conditions. Some Notes on the History of Alkali Action.	A. S. Dawson B. Stuart McKenzie C. J. Mackenzie	Engineering Journal, October, 1920.
The Disintegration of Concrete in Alkali Soils.	G. M. Williams	Engineering Journal, August, 1921.
Report of Calgary Committee on Alkali.	A. S. Dawson	Engineering Journal, September, 1921.
Report of Manitoba Committee on Alkali.	J. N. Finlayson	
1921 Annual Report of Committee to Institute.	C. J. Mackenzie	Engineering Journal, February, 1922.
1922 Annual Report of Committee to Institute.	C. J. Mackenzie	Engineering Journal, February, 1923.
1923 Annual Report of Committee to Institute.	C. J. Mackenzie	Engineering Journal, February, 1924.
1924 Annual Report of Committee to Institute.	C. J. Mackenzie	Engineering Journal, February, 1925.
Concrete Deterioration in Alkali Soils.	C. J. Mackenzie	Engineering Journal, November, 1925.
1925 Annual Report of Committee to Institute.	C. J. Mackenzie	Engineering Journal, March, 1926.
1926 Annual Report of Committee to Institute.	C. J. Mackenzie	Engineering Journal, March, 1927.
1927 Annual Report of Committee to Institute.	C. J. Mackenzie	Engineering Journal, March, 1928.

A study was also made of a number of concrete structures in various stages of disintegration and chemical methods were developed for differentiating between failure of concrete through various agencies, more especially through the action of frost, alkali, or acids. (Differentiation of the Action of Acids, Alkali Waters and Frost on Normal Portland Cement Concrete,—C. J. Mackenzie and T. Thorvaldson, Eng. J., Feb., 1926.) Attempts were also made to determine the lower limit of concentration of alkali water causing disintegration. It was found that ordinary well made concrete under certain conditions of exposure (partial immersion) may be subject to complete disintegration when exposed to sulphate waters containing as low as 0.10% sulphates (as SO_3).

Ordinary alkali water contains a mixture of many salts in solution. It was therefore necessary to study the effect of the various components of these waters on Portland cement. In order that the conclusions should be applicable to concrete structures it was necessary to develop quantitative laboratory methods for measuring the progress and extent of the deleterious action of alkali waters on Portland cement mortars and concrete. A convenient method based on the measurement of the linear expansion of rectangular mortar or concrete prisms, was developed. This method combined with occasional determinations of the tensile or compressive strength gives a complete picture of the physical effects of the action of alkali water on the mortar or concrete. (Expansion of Portland Cement Mortar Bars During Disintegration in Sulphate Solutions,—T. Thorvaldson, R. K. Larmour, and V. A. Vigfusson, Eng. J., April, 1927. Studies on the Action of Sulphates on Portland Cement. I. The Use of the Expansion Method in the Study of the Action of Sulphates on Portland Cement Mortar and Concrete,—T. Thorvaldson, D. Wolochow, and V. A. Vigfusson, Can. J. Research, Sept., 1929.)

The conclusions arrived at were that while the presence of carbonates, bicarbonates and chlorides in small quantities slightly modify the action on the cement yet the deleterious action is almost entirely due to the presence of sulphates in the water. The presence of chlorides, bicarbonates and carbonates in large quantities, however, materially affect the action of the sulphate. The action is also affected by the nature of the basic radical present. It was therefore necessary in making a comprehensive study of possible remedies to determine separately the action of the three sulphates of sodium, magnesium and calcium. (T. Thorvaldson, Eng. J., Sept., 1922; T. Thorvaldson, R. H. Harris, D. Wolochow, Ind. Eng. Chem., *17*, 467, 1925.)

Very extensive investigations had already been made on the constitution of Portland and other hydraulic cements. (G. A. Rankin, J. Ind. and Eng. Chem., *7*, 466, 1915; P. H. Bates and A. A. Klein, B. S. Tech. Paper No. 73, 1917; G. A. Rankin and F. E. Wright, Am. J. Sci., *39*, 1, 1915.) These had been found to be complex mixtures of binary compounds of lime, silica, alumina and iron oxide, with magnesia and gypsum playing minor parts. Later one ternary compound was found to be present in Portland cement. (Studies on the System Calcium Oxide-Alumina-Ferric Oxide,—W. C. Hansen, L. T. Brownmiller, and R. H. Bogue, J. Am. Chem. Soc., *50*, 396, 1928.) Much less was known as to the processes of hydration, setting and hardening of cement and concrete. It was therefore necessary to study these processes in order to gain an understanding of how their normal course is changed by the action of sulphates. For this purpose the following components of hydraulic cements were prepared in the pure state in considerable quantities: tricalcium silicate, beta-dicalcium silicate, gamma-dicalcium silicate, tricalcium aluminate, $5CaO.3Al_2O_3$, monocalcium aluminate, $3CaO.5Al_2O_3$, dicalcium ferrite and $4CaO.Al_2O_3, Fe_2O_3$. Studies made with these compounds have included:—

(a) Microscopic study of the action of the sulphates of sodium, magnesium and calcium on these compounds both in the unhydrated and hydrated forms. (Action of Sodium and Magnesium Sulphates on Constituents of Portland Cement,—Action of Sodium and Magnesium Sulphates on Calcium Aluminates,—Ind. and Eng. Chem., *17*, 589, 1925, and *17*, 1267, 1925; Action of Sodium and Magnesium Sulphates on Portland Cement, Ind. and Eng. Chem., *18*, 854, 1926, G. R. Shelton.)

(b) A study of the hydration products of these compounds. A comprehensive investigation of the hydration products of the aluminates resulted in the discovery of a hydrate of tricalcium aluminate, not before described in connection with Portland cement, and explained many inconsistencies in the results obtained by other experimenters. (The Hydration of the Aluminates of Calcium, T. Thorvaldson and N. S. Grace, Can. J. Research, May, 1929; The Hydration of the Aluminates of Calcium. II. The Hydration Products of Tricalcium Aluminate, T. Thorvaldson, N. S. Grace, and V. A. Vigfusson, Can. J. Research, Sept., 1929.) The work on the hydration of the silicates led to the discovery of definite hydrates of these compounds. These can be obtained in well defined crystalline form in the steam autoclave. (Steam Curing of Portland Cement Mortars. A New Crystalline Substance, T. Thorvaldson and G. R. Shelton, Can. J. Research, July, 1929, and unpublished data.) Work on the hydration products of dicalcium ferrite and the compound $4CaO.Al_2O_3.Fe_2O_3$ is in progress.

(c) A quantitative study of the products formed on the hydrolysis of the calcium silicates with a large excess of water has shown that the equilibrium products in the case of both dicalcium silicate and tricalcium silicate are the same. It has been found that the hydrolysis of the silicates gives a solid hydration product of the composition $3CaO.2SiO_2.x\ H_2O$ when the liquid phase is saturated with calcium hydroxide, but there is not sufficient evidence to prove that a definite compound of this composition exists. The evidence indicates that a hydrated monocalcium silicate is formed when the concentration of calcium hydroxide in the liquid phase is decreased, and that this product takes up calcium hydroxide in solid solution when the concentration of calcium hydroxide is increased. A study of the reaction between limewater and silica sol has shown that the equilibrium is the same as that obtained on hydrolysis of the silicates of calcium. (The Action of Water on Tricalcium Silicate and Beta Dicalcium Silicate,—T. Thorvaldson and V. A. Vigfusson, Trans. Roy. Soc. Can., Third Series, Vol. XXII, Sec. III, 1928, and unpublished data.)

(d) A quantitative study of the hydrolysis of the aluminates of calcium has been made. The results have not been published.

(e) Thermochemical studies. Heats of solution of calcium oxide, calcium hydroxide, tricalcium silicate, tricalcium aluminate and of the various hydrates of the last named substance in $HCl.200\ H_2O$ at 20°C. have been determined. The purpose of this study was to obtain reliable data for calculating heats of formation, hydration, etc., for the fundamental reactions dealt with in cement chemistry. (Studies on the Thermochemistry of the Compounds Occurring in the System CaO-Al_2O3-SiO_2. I. The Heat of Solution of Calcium Oxide in Hydrochloric Acid,—T. Thorvaldson, W. G. Brown and C. R. Peaker, J. Am. Chem. Soc. *51*, 2678-2682, 1929. II. The Heat of Solution of Calcium Hydroxide in $HCl.\ 200\ H_2O$,—T. Thorvaldson and W. G. Brown, J. Am. Chem. Soc. *52*, 80-87, 1930. III. The Heat of Hydration of Calcium Oxide,—T. Thorvaldson, W. G. Brown and C. R. Peaker, J. Am. Chem. Soc. *52*, 910-915, 1930. IV. The Heat of Solution of

Tricalcium Aluminate and its Hydrates in Hydrochloric Acid,—T. Thorvaldson, W. G. Brown and C. R. Peaker, J. Am. Chem. Soc. *52*, 3927-3936, 1930, and unpublished data.)

(f) A microscopic study of the comparative rates of reaction of the sulphates of sodium, calcium and magnesium on the hydrates of tricalcium aluminate, the hydrates of the silicates of calcium and other substances which may be present in set concrete, is nearing completion.

(g) Studies extending over seven years have been made on the action of sulphates on sand mortars made with the various pure cement compounds or mixtures of these as the cement. This work will be discussed later in greater detail. (The Action of Sulphates on the Components of Portland Cement,—T. Thorvaldson and R. K. Larmour, Trans. Roy. Soc. Can., 1927. The Action of Sulphate Solutions on Mortars Prepared from Some Binary and Ternary Compounds of Lime, Silica, Alumina, and Iron,—T. Thorvaldson, V. A. Vigfusson and D. Wolochow, Can. J. Research, May, 1932.)

Methods of Increasing the Resistance of Concrete Against Alkali Action

The main effort of the investigation was exerted towards the discovery of methods for preventing the action of alkali water on concrete. The testing work in connection with this was carried out in constant temperature rooms so that results obtained at different seasons of the year would be comparable. All processes were standardized as far as possible, as by the control of humidity during the making of specimens, etc. A brief summary of the methods found to produce increased resistance of concrete against alkali action follows:—

1. *Methods of Curing*

(a) Steam-curing. Curing in steam very materially increases the resistance of precast mortar or concrete specimens. All samples of Portland cement tested showed this effect, but the cements low in tricalcium aluminate and tricalcium silicate responded better to the treatment than those high in these substances.

While specimens made of normal Portland cement are affected about equally by solutions of sodium and magnesium sulphate of equal molar concentrations, steam-cured specimens are much more resistant to solutions of sodium or calcium sulphate than to solutions of magnesium sulphate. Proper steam-curing may be considered to give complete protection against the action of sodium or calcium sulphate, except perhaps in the case of the combination of very high concentrations of sodium sulphate and severe frost action. It gives also a very highly increased resistance against solutions of magnesium sulphate.

The improvement in the resistance with steam-curing is progressive, increasing with the time of exposure to the steam and with the temperature of the saturated steam up to a certain optimum temperature, which varies somewhat with the chemical composition of the cement, but is generally between 150° and 200° C. Thus 1 : 5 sand mortars when treated with saturated steam at 100° C. improve in resistance to solutions of magnesium sulphate up to 10 days' treatment, but a one-day treatment at 150° C. is more effective than a 10-day treatment at 100° C.

Steam-curing of precast concrete should be carried out as soon as possible after manufacture. The increase in resistance is due to the removal of free

lime by combination of this with the silica in the aggregate to form stable hydrated calcium silicates, to the direct hydration of the dicalcium and tricalcium silicates without hydrolysis and to the formation of the most resistant hydrate of tricalcium aluminate. If hydration of the cement is allowed to proceed far at ordinary temperature the amount of free lime which must be removed by steam-curing is increased and a longer period of steam-curing is required.

Steam-curing of mortars at first produces a sharp decrease in the strength of the specimen, followed by a very marked increase in strength. The increase in strength is to a great extent due to the reaction between free lime and the silica of the aggregate. If the aggregate is not siliceous (for instance if limestone aggregate is used) then steam-curing produces very weak concrete. The aggregate therefore must be clean and siliceous if steam-curing is to be beneficial. (The Effect of Steam Treatment of Portland Cement Mortars on their Resistance to Sulphate Action,—T. Thorvaldson and V. A. Vigfusson, Eng. J., March, 1928. Steam Curing of Portland Cement Mortar and Concrete as a Remedy for Sulphate (Alkali) Action,—T. Thorvaldson, V. A. Vigfusson, D. Wolochow, Can. J. of Research, October, 1929, and unpublished data.)

(b) Combined Damp and Dry Curing. Mortars which are first cured wet until good strength has been attained, and then dried thoroughly, may develop resistance which is many times that of material cured only in water or damp air. A resistance to the action of sulphates more than 10 times that of mortar cured wet has been obtained. The resistance of 1 : 10 mortar to a 1.77% solution of magnesium sulphate was increased approximately 100-fold by alternate moist and dry curing in combination with an exposure to carbon dioxide. Such treatments may, however, cause decreased resistance if they are not preceded by thorough damp curing of the concrete or if the drying is too thorough. The difficulty in applying these methods in practice is that of proper control.

2. *Addition of Integral Compounds*

Integral compounds which have a capacity for combining with calcium hydroxide increase the resistance of concrete in which they are present to sulphate action. The relative capacity of these materials for removing dissolved lime from solution is also a measure of their relative effectiveness in increasing the resistance of a particular Portland cement. The addition of the small amounts of commercial integral compounds as recommended by the manufacturers for the purpose of increasing resistance, workability and watertightness is not effective in increasing resistance to sulphate action, and if added in larger quantities many of the commercial integral compounds actually lower the sulphate resistance of the concrete, in some cases to 25% of normal.

The amount of the lime-removing material added should be enough to combine with all the free lime liberated by the cement during setting and hardening. The amount of lime liberated is roughly proportional to the amount of tricalcium silicate in the cement. Cements low in lime (low in tricalcium silicate, high in beta-dicalcium silicate) therefore require less of the lime-absorbing material to render them highly resistant. Excess of lime-absorbing materials may, however, set up disturbances which cause decreased resistance. These substances increase the resistance to solutions of sodium and calcium sulphate much more than to solutions of magnesium sulphate.

(a) Silica Gel. Addition of this substance to Portland cement renders rich concrete made from the mixture almost immune to the action of moderately concentrated solutions of sodium and calcium sulphate and increases very materially its resistance to the action of solutions of magnesium sulphate. The protection against dilute solutions of magnesium sulphate (up to 2%) is very effective (perhaps 60-fold) but falls off rapidly as the concentration is increased. This substance is at present too expensive to render its use practicable. (The Effect of the Addition of Silica Gel to Portland Cement Mortars on their Resistance to Sulphate Action—T. Thorvaldson, V. A. Vigfusson, D. Wolochow, Can. J. Research, *1*, 385-399, 1929.)

(b) Diatomite. Diatomite in fairly large quantities also increases the resistance to sulphates, although to a very much less extent than silica gel. A threefold increase in resistance has been obtained in the laboratory. Additions in small quantities (1 to 5%) or in large quantities (50% of the cement used) are not beneficial in respect to sulphate resistance.

(c) Volcanic Ash. Large deposits of volcanic ash are available in Saskatchewan. The quality of the material from different deposits varies considerably. The raw ash generally is of little value for this purpose, but calcined ash is in many cases fairly effective. Working with cements high in tricalcium silicate the maximum increase in resistance against a 2% solution of magnesium sulphate was less than twofold for an addition of calcined ash equal to 50% of the cement used. With a cement low in tricalcium silicate the same addition gave as much as fivefold improvement in the resistance to the same solution.

(d) An Asbestos Product. Mr. D. Wolochow, formerly research assistant working on this problem, now associate research chemist, National Research Laboratories, submitted an asbestos product which gives indications of being very useful, and, while not as effective as silica gel, possibly possesses in moderately rich mixes some advantages as a protection against the action of solutions of magnesium sulphate. Testing of this material is in progress.

(e) Common Salt. Addition of common salt dissolved in the mixing water increases materially the resistance to sulphates. Large quantities of salt have an adverse effect on the strength of the concrete, but considerable increase in resistance is produced before the strength begins to be affected.

(f) Surface Water-proofing of Concrete. The work in this field has been mainly concerned with testing out commercial products. Surface coatings without strong membranes have been found to be of only temporary benefit. Membrane water-proofings have been found to be fairly effective but tend to become permeable with age. Workmanship in applying the membrane water-proofing becomes of prime importance. While this method cannot be considered a permanent solution of the problem, membrane water-proofing should be strongly recommended in the case of concrete exposed to alkali water if better protection is not available.

3. *Modification in the Composition of the Cement*

In a paper published in 1927 (The Action of Sulphates on the Components of Portland Cement,—T. Thorvaldson, V. A. Vigfusson and R. K. Larmour, Trans. Roy. Soc. Can., 1927) it was shown that the component of Portland cement most susceptible to the action of sulphates is the tricalcium aluminate. In 1928 Hansen, Brownmiller, and Bogue discovered a substance of the composition $4CaO.Al_2O_3.Fe_2O_3$, which is probably present in Portland cement. In 1928 a study was begun of sand mortars containing singly or as mixtures all the compounds of lime, silica, alumina, and ferric oxide known to be

present in hydraulic cements. The results of this study, which covered the field of Portland, high alumina and iron ore cements, led to very important conclusions as to the ideal composition for sulphate-resisting cements of these types. The results (The Action of Sulphate Solutions on Mortars Prepared from Some Binary and Ternary Compounds of Lime, Silica, Alumina and Iron,—T. Thorvaldson, D. Wolochow and V. A. Vigfusson, Can. J. Research, 6: 485, 1932) may be summarized as follows, as far as they deal with sulphate resistance of cements:—

1. All Portland cements high in lime and containing normal amounts of alumina have low resistance to natural waters containing sulphates of magnesium, sodium or calcium. The higher the lime content of the cement (*i.e.*, the higher the percentage of tricalcium silicate), the alumina remaining the same, the lower is the resistance of the cement to the action of the sulphates.

2. In the case of Portland cements high in lime (high in tricalcium silicate in comparison with the beta-dicalcium silicate present) the resistance to the action of sulphates can be increased by decreasing the percentage of alumina (reducing the amount of tricalcium aluminate) or increasing the percentage of ferric oxide (changing tricalcium aluminate to $4CaO.A1_2O_3.Fe_2O_3$) or by both of these simultaneously. The resistance cannot be increased to equal that possessed by the pure silicate mixture present in the cement.

3. In the case of Portland cements low in lime (high in beta-dicalcium silicate as compared with tricalcium silicate) the resistance to solutions of magnesium sulphate can be increased by the methods described in the preceding paragraph, so that it becomes much higher than the resistance of the corresponding mixture of the pure silicates. While the resistance to solutions of sodium sulphate and calcium sulphate cannot be increased to that of the silicate mixture, an extremely high resistance to these solutions can be obtained by this method.

4. In practice the limit to which the resistance can be increased by the methods in paragraph (3) is determined by the requirements of early strength, since high later strengths are obtained with such mixtures.

5. High alumina cements, in order to have the highest resistance to the action of sulphate, should be of a composition which gives no aluminate higher in lime than monocalcium aluminate, and the silica should be present as beta-dicalcium silicate. The presence of a large quantity of the aluminate, $3CaO.5A1_2O_3$, is probably not desirable on account of the lower strength and the action of water on this substance.

Application to the Commercial Manufacture of Cement

Shortly after the publication of the 1927 paper on the action of sulphates on the components of Portland cement, the Canada Cement Company, under the direction of their chief chemist, Mr. A. G. Fleming, attempted to modify the composition of the cement manufactured at their Exshaw plant, and later at their Winnipeg plant, so as to reduce the content of tricalcium aluminate and thus to obtain a product of higher resistance to sulphate action. In these attempts the company had the co-operation of Dr. Thorvaldson, both in an advisory capacity and in the testing of the sulphate resistance of the cements produced. These attempts were partly successful in that cement of higher resistance than the ordinary product was produced, but the reduction of alumina, the main fluxing material of the raw mixture,

caused difficulty in burning of the product so as to obtain combination of all the lime. Some of the products contained considerable quantities of free lime, which lowered the resistance of the cements.

To insure complete combination of the lime and to facilitate burning, Mr. Fleming decided to increase the percentage of ferric oxide in the mix, this being the chief fluxing material in Portland cement, alternative to alumina. Early in June, 1931, a run embodying this idea was made at the Canada Cement Company's plant at Exshaw, under the direction of Mr. Fleming and with the co-operation of Dr. Thorvaldson, who calculated a series of raw mixes based on the analysis of raw materials available. Unfortunately the shale proved somewhat lower in silica and higher in lime than was anticipated, but in spite of this fact some cement was made of very high resistance to sulphate action.

A second experimental run at Exshaw with the high silica shale which had now been located and brought in to the mill, was made by Mr. Fleming in November, 1931. Dr. Thorvaldson again submitted calculations for raw mixes based on analyses of raw materials. Samples of the cements produced during both runs were sent to his laboratory for testing, and this is now in progress.

The commercial production of alkali-resistant cements may be considered to have confirmed the results obtained in the laboratory investigation, upon which they were in part based. With careful plant control and further slight changes in composition it is probable that cements of this type can be produced which are even higher in resistance to alkali action than those so far manufactured.

High Alumina Cement

The high alumina cements tested in the early years of this investigation were found to be extremely variable in sulphate resistance. The American high alumina cement available was found to be only slightly superior to Portland cement in lean mixes, although rich mixes were considerably more resistant than the corresponding mixes of Portland cement. At present some high alumina cements of British manufacture are being tested. The results so far obtained indicate that these are extremely resistant to the action of magnesium sulphate when used in fairly rich mixes. The only other material which is comparable in its resistance to magnesium sulphate is steam-cured Portland cement mortar.

Prodorite

Samples of this material have been submitted for testing. So far there is no evidence of attack on these samples by the sulphate solutions to which they are exposed.

(Investigation under the direction of Dr. T. Thorvaldson, University of Saskatchewan, and Dean C. J. Mackenzie, Chairman of the Committee on the Deterioration of Concrete in Alkali Soils, Engineering Institute of Canada.)

Wireworms of the Canadian Prairies

Co-operating organization:

University of Alberta

Wireworms and false wireworms which are the larvae of beetles of the genera *Ludius* and *Eleocles* respectively, have been a serious pest in the grain fields of the Canadian prairies for many years, and despite efforts at control, are slowly but surely increasing.

The problem of their control is extremely complex and presents innumerable difficulties arising in both experimental technique and in the enormous numbers of plants and volumes of soil that must be examined in order to obtain satisfactory data.

Investigations have been carried out during 1931 on the possible beneficial effects of shallow seeding, the use of the press drill and cross-packing after seeding. The observations made are as yet too few to allow of positive statements regarding them, but as far as could be determined, there was little to choose between the methods mentioned. However, there seemed to be less actual feeding where the plots were seeded only 2 in. deep, by means of a press drill.

Following on the discovery of a rapid method of determining the sex of adult beetles, it has been found that the numbers of migrating females are less than would be expected from the numbers of beetles seen upon the surface of the ground. Females apparently move little if at all, after mating in March or early April, until the time of depositing their eggs. The majority of the visible wanderers are males that have already mated and are thus not involved in the spread of the pest as a whole.

In spite of numerous attempts, no success was obtained in inducing females to lay eggs in field cages, hence no data have been obtained regarding the depth of oviposition in the field, as affected by climatic conditions and the texture of the soil.

Investigations carried on in the Peace River district indicated the possibility that the relatively great damage there, might be due to a low rate of evaporation of soil moisture. The failure of control measures, claimed to be efficacious elsewhere, may have been due to the same cause.

It was noted, however, that the damage was sometimes offset to some extent, in that fields which had been thinned out by wireworms in May were occasionally saved from complete destruction by drought in July, when the soil moisture fell too low to maintain a full stand of plants. This effect was absent, if the eliminated plants were replaced by weeds.

Field experiments carried out on the food requirements of newly hatched larvae confirmed earlier laboratory findings, namely, that the common dicotyledonous weeds have only a small influence on the survival of young larvae during the summer in which they hatch.

Wheat was again found to be the most satisfactory food, with oats and other grasses as fair substitutes. Timothy was found to be an exception, no larvae surviving on it as a sole food. It appears that plants of the graminae are necessary for a high percentage survival of newly hatched larvae.

(Investigation under the direction of Dr. E. H. Strickland, University of Alberta.)

Microbiology of Farm Soils of Quebec

Co-operating organizations:

Macdonald College

Quebec Department of Agriculture

The work outlined in the previous annual report has been continued and expanded. Representative virgin soils from the counties of St. Hyacinthe, Missisquoi, Montmagny, Vaudreuil, Yamaska, Joliette, Nicolet and Lotbinière, in the province of Quebec, have been studied to determine micro-

biological activity. Determinations have been made of the number of micro-organisms, degree of nitrification, carbon dioxide content, water-holding capacity, moisture during the process of nitrification and rate at which nitrification occurs during desiccation and under controlled moisture conditions.

As a result of these investigations, it has been found that micro-organisms are more numerous in clay soils than in sandy soils containing a high percentage of moisture. With a few exceptions, nitrates were absent from fresh soils, but bacterial transformation of the soils' own nitrogen was found to be extensive when such soils were incubated at about the optimum water-holding capacity.

Nitrification, in the case of clay and sandy clay soils, increased still further after drying and remoistening to optimum moisture content. It was not observed, however, in what are known as "podsol" soils, that is, soils in which there is an upper layer rich in semi-decomposed organic matter, a middle, relatively shallow layer, poor in both organic matter and soluble mineral salts, usually of an ashen color, and a foundation, darker in color, with no undecomposed organic material, but rich in nutrient salts, etc.

The carbon dioxide evolution and water-holding capacity were greatest, on the average, in soils containing clay. The moisture content of such soils was found to be near the optimum for an important group of soil organisms. In the case of podsol soils, those from the uplands were found to have a greater water-holding capacity than those from the lowlands.

(Investigation under the direction of Prof. P. H. H. Gray, Macdonald College, McGill University.)

Soil Investigations in Quebec

Co-operating organizations:

Macdonald College
Quebec Department of Agriculture

Extensive studies have been made during the past three years of the various classes of soils found in the cleared lands of Quebec, their peculiarities, distribution and extent, for it had been observed that in many areas where crop yields were low or where it was difficult to produce any crop, there was not a proper balance between the mineral constituents and the organic matter in the soil.

In work previously reported stress was laid on the need for information on the deficiencies of various soils and the locality of the several types, and data based on studies extending over two years were given.

With this background the investigators were able during the past year to make a more intensive study of means for the improvement of sour lands in which the accumulation of acid organic matter on the surface is the characteristic feature and principal cause of the loss of fertility. Various methods for the appraisal and treatment of such lands were examined.

Tentatively it has been established that the farm lands of the province embrace at least eight distinct classes of soil, each of which has characteristic chemical, physical and biological features. These types of soil have been evolved over long periods of time as the result of the varying geological and climatic conditions to which they have been submitted.

While the subject of soil nomenclature is still a matter of discussion, the several types in Quebec may be classified as follows: (1) Upland podsol; (2) Lowland podsol; (3) Heavy clay; (4) Sandy clay; (5) Upland muck swamp; (6) Lowland muck swamp; (7) Brown forest soil; (8) Orchard soil.

It may be observed that "podsol", a folk term applied to the gray soils of northern Russia, has been adopted in American literature to designate the soils of similar character found in southern Canada and in northern United States. In both chemical and physical characteristics podsols are poor soils, consisting usually of a surface layer of raw humus up to a foot in thickness, overlying an acid gray to nearly white upper mineral horizon of highly leached material, and a dark brown subsoil having a relatively high content of organic matter, iron and alumina.

Laboratory studies of typical soils have yielded results of distinct promise. For example, in soils of the "upland podsol" type, or infertile land which has been leached and consists chiefly of semi-decomposed, acid organic matter, it has been found that the nitrogen content may be as high as 6000 lb. per acre to plough depth. It is the purpose of this research to find means of rendering this nitrogen assimilable by crop plants. In view of the widespread areas in which these unproductive soils occur, it is obvious that such a discovery would be of great national significance and value. Laboratory tests point to sodium carbonate and slaked lime as possible corrective agents.

Progress in the study of Quebec soils during the past year has been made along two lines. In the first place, the effect of scores of chemicals on the acid organic matter of sour soils was investigated and it was found that the chemicals mentioned above were the most useful of the practical corrective agents. Theoretical support for this result is also found for the "black alkali" soils of arid regions that have a high content of sodium carbonate and sodium acid carbonate, opposite in their characteristics to the acid soils of the podsol type, which are rich in organic matter. When used in reasonable amounts the cost of sodium carbonate is not prohibitive.

Theoretical scientific data of some interest were also adduced. Using a special percolation method in the treatment of soils to which only small amounts of alkali had been added the investigators obtained colored but non-turbid solutions. Quantitative analyses of these solutions are now under way.

(Investigation under the direction of Dr. R. R. McKibbin, Macdonald College, McGill University.)

Barley versus Corn as Poultry Feed

Co-operating organization:

University of Manitoba

Manitoba is the chief barley-growing province in Canada, having produced in 1930 approximately 50 million of the total Dominion crop of 135 million bushels. Difficulties in the marketing of other grains, coupled with largely increased output of barley in other countries, especially Europe, have created a problem in respect to the distribution of Canadian barley.

In view of the large tonnage of corn annually imported into Canada for use as feed it was decided to make a preliminary investigation to determine the relative values of barley and corn as poultry feed. The results of the initial experiments were so satisfactory that the facts were placed before the National Research Council, with a request for a grant to make possible a comprehensive study of the use of barley in various forms and combinations and in comparison with corn rations.

The object of the first experimental work was to determine the value of two popular varieties of barley as a feed for growing chicks, and to indicate in what form or food combinations it should be fed.

Two lots of baby chicks were fed the same rations for 12 weeks and careful observations made of their growth. In the first experiment 7 lots of 30 White Leghorns each were under observation from March 21 to June 13; in the second experiment 10 lots of 50 White Leghorns each were studied from June 1 to August 24.

The basic standard ration fed to the control pen consisted of finely ground wheat, oats and corn in equal parts plus 25% of supplements, including meat and fish meal, milk powder, alfalfa meal, oil cake, oyster shell, grit, charcoal, salt and cod liver oil. Each of the other six lots received exactly the same rations except that the 25% of corn was replaced by an equal weight of: (a) O.A.C. 21 barley, finely ground; (b) O.A.C. 21 barley, ground and the hulls sifted out; (c) O.A.C. 21 barley, hulled and ground; (d) Trebi barley, ground; (e) Trebi barley, ground and the hulls sifted out; (f) Trebi barley, hulled and ground.

The protein content of these feeds varied only about 2% from a low of 18·41 to a high of 20·48% in the first experiment and from 19·80 to 21·79% in the second experiment.

Weights of the chicks in each lot were observed week by week and the average weight per chick calculated. The weight and cost of the rations were also recorded.

As a result of these two experiments, it has been shown that barley, when fed to young chicks, is fully equal to corn in growth-promoting qualities and it is very much cheaper. It was observed, however, that chickens fed the barley ration were not quite as well fattened nor as well finished as broilers, at 12 weeks of age, as those fed the corn ration, but it was thought that this apparent deficiency could be easily corrected by making a slight change in the ration without increasing production costs.

With reference to the grains fed, the investigators found that O.A.C. 21 barley, finely ground and with the hulls left in, is superior to corn, and also superior in feeding value to Trebi barley.

Sifting out the hulls did not improve the feeding value of the barley. Both varieties of barley in the unhulled state, unsifted, and hulled for five and ten minutes, very successfully replaced corn, but when hulling was continued for 20 minutes the process appeared to remove some valuable food constituent. The opinion was that the investigation with regard to the extent to which hulling can be carried out, without lowering the food content, should be continued.

A further research on the relative values of barley and corn in the feeding of laying hens was begun in November, 1931, and results already obtained indicate that barley is fully equal to corn for this purpose, both in respect to amounts fed and in combinations made with other grains, and also in relation to protein and mineral supplements. Rates of egg production, variations in fertility, and hatching quality of the eggs, and a study of the vigor and vitality of chicks hatched from them, are other phases of the problem that are being investigated.

The introduction of barley into poultry rations will mean lower production costs to the poultryman and an increased home market for Canadian barley.

(Investigation under the direction of Professor M. C. Herner, University of Manitoba.)

Mineral Constituents of the Floral Parts and Young Fruits of the Apple

Co-operating organization:

Acadia University

The investigations outlined under the above title in the fourteenth annual report have been extended, and further confirmatory results obtained. The following samples have been analyzed: 19 of pollen-containing anthers, five each of pollen and anthers separately, 19 of very young fruit collected at the blossom stage and 10 of young fruit gathered at the so-called "first drop" stage.

As in 1930, varietal differences in composition were noted and pollen-containing anthers from good pollinizers were found to be higher in dry matter and potash content and lower in lime and magnesia content than similar tissue from poor pollinizers.

The effect of cultural and nutritional conditions upon tissue composition was even less marked than in 1930; indeed, it may be said that as far as the constituents which were determined in this investigation are concerned, the composition of the tissues of pollen-containing anthers of the apple are relatively constant under widely different cultural and nutritional conditions.

In the case of the young fruit of the Gravenstein and Wagener varieties, small differences were observed in the phosphoric acid and potash content, and it appears that the use as fertilizers of barnyard manure, acid phosphate or basic slag, or a 9-5-7 artificial mixture, has the effect of increasing the average dry weight of the fruit, and also the percentage of moisture in the fruit. It is not considered, however, that the variations in composition resulting from the use of these fertilizers are of vital significance in relation to the fertilization of the bloom or the setting of fruit, unless they are found to occur regularly over longer periods than two seasons.

It is suggested that the relatively high proportions of lime, magnesia and phosphoric acid, and the low proportion of potash found in young fruit, as compared with the relative amounts of these constituents in mature fruit, may be of some importance in relation to the nutritional requirements during the period of fertilization of the bloom and setting of the fruit.

It was noted that the lime content of the ash of fruit at the "first drop" stage was about five times that of the ash of mature fruit, and increased appreciably during the interval between blossoming and setting of the fruit.

It was also observed that in the limited number of samples studied, the pollen from good pollinizers was considerably lower in lime and magnesia and appreciably higher in potash than that from varieties known to be poor pollinizers. The anthers alone from these two types were, however, very similar in composition, the poor pollinizers showing a somewhat higher content of phosphoric acid.

Preliminary experiments were also made with the object of determining the nature of the compounds in which the various ash constituents are present in the pollen-containing anthers.

(Investigation under the direction of Dr. W. A. DeLong, Acadia University.)

Bark Disease of the Beech

Co-operating organization:

Nova Scotia Department of Lands and Forests

The research outlined in the fourteenth annual report has been continued and considerable knowledge gained of the causal factors and the progress of the disease. Most important of all, a method of control, giving satisfactory results when conscientiously applied, has been worked out.

The plots laid out and examined in 1930, and containing over 1,400 described trees, have been re-examined and show a striking spread of the disease. In addition, numerous trees have been marked with an India ink grid, all lichen colonies, fungal lesions, etc., being located with respect to the lines of the grid. It will thus be possible to determine the changes from year to year by comparison of records made in this manner.

A valuable result of these investigations is the discovery that mosses and lichens provide shelter for the scale *Cryptococcus fagi* (Baer) Dougl., which either carries the pathogenic fungus or paves the way for fungal infection by injuring the bark of the tree.

To obtain information regarding the mode of infection and the causal organism, healthy trees have been inoculated in various ways and combinations with the scale and the suspected fungus (*Nectria*, a native species). From these experiments it appears that either scale or fungus alone is unable to cause the disease, but that the fungus, following the scale, causes rapid destruction.

Further observations have been made on the time and rate of spore discharge, on means of spore dissemination, and on the relation between spore discharge and weather conditions.

The work on a method of control has consisted of adequate tests of various oil sprays, black leaf 40, lime sulphur, etc., from which it appears that a miscible oil known as "Sunoco" in dilutions of 1-15 with water, carefully and thoroughly applied so as to wet all the bark with its adherent scales, will give good control.

In the case of small and valuable stands of only a few trees, excellent results have been obtained by scrubbing the bark with long-handled brushes dipped in the spray mixture. This gives even better results than does spraying, but, on account of the labor involved, is not always practical.

Published paper:

Ehrlich, J. The Occurrence in the United States of *Cryptococcus fagi* (Baer) Dougl., the Insect Factor in a Menacing Disease of Beech. J. Arnold Arboretum, 8:75-80. 1932.

(Investigation under the direction of Mr. O. Schierbeck, Nova Scotia Department of Lands and Forests.)

Gas and Water Content of Trees and the Sinkage Problem

Co-operating organizations:

Canadian Pulp and Paper Association
McGill University
Price Brothers and Company, Ltd.

As pointed out in the fourteenth annual report, the cheapest method of getting trees to pulp and paper mills is by driving the logs down small

streams. During the trip, about 10% of the logs become water-logged and sink, and are thus lost. This loss depends on the rate at which water displaces air in the logs as well as on the water content of the wood at the time of cutting.

The work of the past year confirms that of the previous year, no appreciable seasonal change being found in the water content of jack pine, spruce or balsam, while that of birch and poplar showed a marked decrease during the summer. This decrease was greater in 1931 than in 1930, and may have been due to the dry winter of 1930-31. The time of cutting birch and poplar will therefore be governed by wood conditions, except when girdling is practiced.

Observations have been made upon the effect of girdling (removal of a ring of bark and wood from the tree) as a means of regulating the water content of trees. It was found that girdling birch to a depth of one inch did not alter the water content in two seasons, and in view of the fact that it resulted in an extensive spoiling of the sapwood above the girdle, due to fungal infection, it cannot be recommended in this case. The removal of the sapwood by girdling to a depth of approximately one inch resulted in rapid desiccation of the sapwood above the girdle in the case of balsam, but the characteristic wet patches of the heartwood remained unchanged. It was noted also that such deep girdling increased the percentage of windfalls of young balsam trees, due to the relatively slender heartwood. The results of girdling spruce trees are as yet inconclusive.

Preliminary work on the diurnal changes in the water content of trees demonstrated the existence of a more or less regular cycle involving a loss of water during the early part of the day followed by practically complete recovery during the latter part of the day, and during the night.

Experiments on flotation and seasoning in the field and laboratory emphasized the importance of end-penetration of water into floating logs. This is of course proportionally greater in short logs, thus offsetting the more rapid seasoning of such logs prior to their being placed in the stream. Painting of the ends was found to decrease end-penetration very materially.

The effect of "top drying" (the evaporation of water from the exposed upper part of a floating log) was investigated, but owing to the complex nature of the factors involved, the problem has not yet been fully worked out. It appears, however, that the loss of weight in top drying is far from negligible, especially in quiet waters where logs show little tendency to roll over. The effect is least in well seasoned logs, hence painting the sides of such logs (especially when peeled) to prevent a re-entry of water is advantageous. It is, on the other hand, a distinct disadvantage with poorly seasoned logs, since in this case top drying, which is likely to be more marked, is prevented, while the protection against water re-entry is valueless owing to the fact that such re-entry into a poorly seasoned, wet log is slight.

Work upon the effect of peeling the bark from logs prior to piling and flotation is as yet unconvincing, though it appears that such peeled logs season more rapidly if protected from rain. On the other hand, they also take up water more rapidly when floated. The development of cracks in peeled trees appears to increase the rate of water intake upon flotation. Piled unpeeled birch logs lose very little water during their time in the pile.

Further work is planned for the season of 1932-33.

Published paper:

Gibbs, R. D. Further Notes on the Water-content of Trees, on the Effect of Girdling and on Certain Seasoning and Flotation Experiments, with Reference to the Sinkage Problem.

Woodlands Section, Can. Pulp and Paper Assn., Montreal, Jan. 1932.

(Investigation under the direction of Mr. R. D. Gibbs, McGill University.)

Preparation of Anthraquinone Vat Dyes

Co-operating organization:

Laval University

By condensing diethyl malonate with benzaldehyde (or its *o*-chloro- or *o*-hydroxy-derivative) and treating the product with anthranone a compound is obtained which on hydrolysis yields β-anthronyl-β-phenyl-propionic acid. The chloride, amide, anilide and methyl and ethyl esters of this acid were prepared in an attempt to produce ring formation to a benzanthrone derivative. It is thought that two molecules of this derivative will condense to form a vat dye analogous to violanthrone which is obtained by condensation of two molecules of benzanthrone itself.

The condensation products of anthranone with *o*-chloro- and *o*-hydroxy-benzaldehyde were also prepared.

(Investigation under the direction of Prof. P. E. Gagnon, Laval University.)

Continuity of Welded Steel Beams

Co-operating organization:

University of Toronto

The use of welded connections in steel structures of all kinds is spreading, although knowledge of the best and most economical connections for many situations is as yet meagre.

During the past year it has been possible to complete the experimental work involved in investigating the problem of continuity and rigidity in steel beam connections outlined in the two previous annual reports, and to make substantial progress in the analysis of the data obtained.

The series of 18 full-size double-cantilever specimens, made up of 18-in. steel I-beams from 10 to 11 ft. long proved to be highly fruitful in yielding information of a kind sought by engineers concerned with the problems of restraint and stiffness. Relative rigidities of different types of specimens have been indicated and much light has been thrown on the sources of deformation in both welded and riveted connections.

While sufficient ground has been covered in the analysis to show beyond any doubt that the investigation has been, and will be, a profitable one, it is not practicable to generalize until all the experimental data have been carefully studied. It is believed that when this is done, conclusions of considerable importance to engineers and to the construction industry may be drawn.

(Investigation under the direction of Prof. C. R. Young, University of Toronto.)

Lateral Support of Steel Columns and Struts

Co-operating organization:

University of Toronto

Test data on a series of 19 steel columns which were loaded up to failure for various deflections, eccentricities of load application, and lateral support, have been obtained during the past year. Such data have been needed by engineers in the designing of struts and columns and already many requests for detailed information concerning the investigation have been received.

Detailed study of the data is under way and it is expected to make possible the formulation of rules and formulas of much value to engineers.

(Investigation under the direction of Prof. C. R. Young, University of Toronto.)

The Generation of Electricity by Windmills

Co-operating organization:

University of Saskatchewan

An experimental windmill for generating electricity for farm use has now been in operation for several years. Details regarding its construction and its possible value to western farmers have been given in previous annual reports. Recently efforts have been directed towards determining repair costs and output of electricity.

A number of changes in design of the generator and of the windmill have been shown to be necessary for maximum efficiency. Since the relatively short life of the storage batteries is one of the most important factors in cost of operation, work is now being carried out under a new plan whereby the discharge of electricity is controlled to prevent overcharging of the batteries with the object of lengthening their useful life.

(Investigation under the direction of Prof. A. R. Greig, University of Saskatchewan.)

The Structure and Physiology of Fungi

Co-operating organization:

University of Manitoba

This research was undertaken in order to throw further light on certain fundamental problems in the structure and physiology of fungi. Assistance has also been given in bringing to completion Vol. 5 of *Researches on Fungi*, Vols. 1-4 of which have already been published.

During the year the work has been concerned with the *Discomycetes*, *Hymenomycetes* and *Gastromycetes*, and in particular with the mould *Pilobolus*, with an as yet unidentified species of the genus *Coprinus* (to which belong some mushrooms and toadstools) and with various species of the genus *Umbonatus*. The process of reproduction in the *Pyrenomycetes*, a sub-order containing many plant pathogenic fungi, has also been studied. Work of considerable importance in the treatment of certain skin diseases due to fungi has been carried out.

Hitherto it has been necessary to wait, often several months, until spores appeared on the fungal growth before it could be identified. The work of the last year has shown that if fungi isolated from the skin lesions be grown under proper conditions in close proximity to laboratory specimens of known species, hyphal fusions occur between the hyphae (branching portions) of the unknown and any one of the known species which is of the same species as the unknown, and in no other case. It is thus possible to identify these pathogenic fungi in a few weeks, with consequent advantage to the patient.

Published paper:

A. M. Davidson, Eleanor S. Dowding and A. H. R. Buller, Hyphal Fusions in Dermatophytes. Can. J. Research, 6:1-20. 1930.

(Investigation under the direction of Dr. A. H. R. Buller, University of Manitoba.)

Slough Itch

Co-operating organization:

University of Saskatchewan

Many pools or sloughs on the prairies are infected with parasites from water snails. These parasites penetrate the skin of persons wading or swimming in such waters, causing a condition variously known as slough itch, swimmers' itch, and other local names. The parasite is the larval stage of a flat worm living in the blood-vessels of some warm blooded animal, and the snail is the secondary host necessary in the life-cycle of these worms. Man is not the primary host and the parasite dies after causing the typical "itch".

The problems involved in this investigation are the extent of infection on the prairies, the number of species of the parasite responsible, whether one or more, and particularly the discovery of the primary host.

Snails were obtained from itch-infested places at five localities in southern Saskatchewan in an effort to discover various species of the parasite, but in all cases only *Cercaria elvae* was recovered. It seemed probable therefore that the problem is not complicated in Saskatchewan as it is in parts of the United States by a mixture of species, and when recommendations can be made in one place they should apply equally well all over the province. The known range of the parasite has been extended to British Columbia by its recovery from snails sent from Paul Lake near Kamloops by Dr. D. S. Rawson, the itch having been reported in that lake.

Search for the primary host of the parasite was continued to a limited extent during the year, but progress was hampered through the disappearance of the only suitable pool in the vicinity of Saskatoon during the unusually dry weather. Although no positive results have been obtained, the negative results from a series of infection experiments and the examination of a wide range of lake-frequenting animals and birds are valuable in advancing the knowledge of the bionomics of the parasite.

Infection was attempted with a number of white rats (which take *Cercaria douthitti*, the American itch parasite, very readily) and with wild mice, but post-mortem examination after sufficient time had elapsed to allow complete development failed to reveal the adult parasite in the blood-vessels. Examinations of shrews and shore birds were similarly negative.

A full description of the discovery of the adult and the life history of the American itch parasite *Cercaria douthitti* was published in the American Journal of Hygiene, 13: 685-727, 1931, but the Canadian species *Cercaria elvae* has not yet been described.

Work on this subject will be continued.

(Investigation under the direction of Dr. L. G. Saunders, University of Saskatchewan.)

The Influence of Helminth Parasitism upon the Abundance of the Snowshoe Rabbit in Western Canada

Co-operating organization:

University of Manitoba

It has been known for at least a century that *Lepus americanus*, the Snowshoe rabbit of western Canada, is subject to periodic fluctuations in abundance, paralleled by similar fluctuations in the abundance of animals preying upon it. These fluctuations are of economic importance, since they affect to a large extent the fur catch of the trappers in western Canada.

On the hypothesis that these fluctuations are due to the effects of periodic outbreaks of epidemic disease, an examination has been made with regard to infestation by worms of 420 rabbits in Manitoba.

In this study, 11 species of internal parasites have been found, certain of which are no doubt capable of producing epidemic mortality when present in sufficient numbers.

The percentage of rabbits infested appears to depend not only upon the percentage of moisture in the soil in a given locality, but also upon the type of soil, varying from a minimum in the southwestern part of Manitoba to a maximum in the eastern part of the province.

It appears that the periodic fluctuations of rabbits in western Canada are induced by overpopulation, which favors parasitism, and by abnormal rainfall, though the latter would not be expected to cause an epidemic in a year of minimum rabbit abundance, owing to the chances of infestation being reduced by the relative scarcity of hosts. As the rabbit population rises, the percentage of infestation increases, until finally, after a severe winter, or during the winter, the vitality of the rabbit population becomes diminished, and epidemic mortality occurs.

(Investigation under the direction of Prof. R. A. Wardle, University of Manitoba.)

Electrostatic Studies on Milk and Milk Products

Co-operating organization:

University of Alberta

It is well known that milk is peculiarly liable to variations in quality, brought about by bacterial contamination. It is a matter of importance, then, that not only should simple and rapid tests be known for estimating the quality of milk, as affected by bacterial growth, but also, that the accuracy and reliability of these tests should be thoroughly investigated. Such studies are now in progress in the work outlined below.

Milk has commonly been tested for bacterial content by the use of methylene blue. If small quantities are added to milk (one part in 200,000), a blue coloration results which disappears after a varying time interval, depending partly at least on the type and degree of bacterial contamination of the milk. This change, known as "reduction" is due to a transformation of methylene blue to methylene white, hastened by the action of bacterial products in the milk.

Methylene blue, however, is not ideal for this purpose, and a study is being made of another dye, resazurin, with regard to its suitability as a substitute for methylene blue. This work is being done largely by means of electrical determinations of the minute acidity changes occurring in the milk during the period of test. The data are not yet complete.

Studies have also been made of the yeasts and moulds found in milk, and since these produce acidity, their growth is being examined by electrical determinations of acidity. Further and more detailed work of this nature is planned for the year 1932-33.

Investigations of the reliability of certain other milk tests will also be carried out.

(Investigation under the direction of Dr. H. R. Thornton, University of Alberta.)

Feed Flavor or Stable Odor in Milk

Co-operating organization:
University of British Columbia

Continuing the work outlined in the annual report for 1930-31, the various strains of bacteria isolated from sources in and around barns have been thoroughly investigated, 104 strains being studied.

One hundred and two of these have been classified. Of these, 58 strains are placed in the genus *Aerobacter*, and all but five of these have been determined to species, among which are *Aerobacter oxytocum*, *A. oxytocum* (atypical), *A. aerogenes*, *A. aerogenes* (atypical), and variants of *A. cloacae*.

The remaining 44 strains are placed in the genus *Escherichia*, 42 being determined to species. Among these were found strains of *Escherichia coli*, *E. enterica*, *E. formica*, *E. vesiculiformans*, *E. communior* and *E. neapolitana*.

The remaining two organisms have not yet been classified.

Observations have been made on the intensity of the flavor and odor produced in milk by freshly isolated bacteria and by organisms grown in artificial media for some six months.

Certain cultures have been found to produce the characteristic feed flavor and stable odor throughout. On the whole, bacteria from the genus *Aerobacter* produce a more pronounced feed flavor and stable odor in milk than do those from the genus *Escherichia*.

It should be noted that these bacteria were isolated from various objects in and around barns, such as baled alfalfa, scrapings from mangers, grain mixtures, granary bins, pieces of cut mangels, a beet pulp shovel, milk sheet blotters, milk stools, grooming brushes, etc., etc., but are *not* present in the milk within the udder of a normal healthy cow.

It is thus seen that the control of feed flavor or stable odor in milk is reduced to a matter of common cleanliness in the barn and milk rooms,

and that the presence of the flavor is a sign of carelessness on the part of the producer. It appears also that the degree of cleanliness practiced on a given farm can be estimated from examination of types of bacteria found in the milk, and can be estimated on a basis superior to that of the score card in common use.

(Investigation under the direction of Prof. H. M. King and Prof. W. Sadler, University of British Columbia.)

Reproduction of Print for the Blind

Co-operating organization:

University of Manitoba

The objects of the experiments which are being carried out in this investigation are:—

(1) To produce a machine which will outline the shapes of typescript letters, tangibly, on the fingers of a blind person, and thus make the world of literature available to him.

(2) To do this with apparatus as simple and convenient as possible.

(3) To keep the cost of the machine such that it will be a practical investment for the blind individual.

The method used to get the desired effect is briefly as follows:—

Five points of light in a vertical row as high as one line of print are reflected successively into a photo-electric cell from the printed line, and the cell actuates successively through an amplification unit, five solenoids controlling five points touching the finger of the reader.

At one end of a wooden base, about 14 in. long by five inches wide, is mounted a small electric motor, which drives a one-inch shaft, 10 in. long, directly in line with its axis, and mounted at each end in a bearing. About one inch from the motor on this shaft is a commutator, which is connected to the five different solenoids under the finger rest. Three inches further along and directly under and close to the shaft is placed a small electric lamp, one inch in diameter, with a steady light, similar to the exciting lamp of a sound machine. About one and one-quarter inch from this a condensing lens is placed. Close to this, mounted on the shaft, is a revolving disk with five slits at varying distances from the axis. This cuts the light from the lens into five vertical levels. This disk is synchronized perfectly with the commutator.

Next to the disk is placed an opaque screen with a vertical slit, which concentrates the light on a very narrow vertical section of the letter. This base is fastened in a box about 20 in. square by 12 in. deep, so that the light which focuses to the height of a letter, about six-and-one-half inches in front of the opaque screen, will be projected through a one-quarter-inch hole in the front of the box.

The printed page is moved evenly across the hole, and the light is reflected back from the white parts of the page into a photo-electric cell, which is mounted beside the motor base at the correct angle to catch the reflected light.

(Investigation under the direction of Dr. F. Allen, University of Manitoba.)

The Production of Polysaccharides by Bacteria

Co-operating organizations:

McGill University
University of Toronto

The investigation of the action of certain micro-organisms on carbohydrates and of the products thus formed, has been continued during the year under review. This work covers three groups:—

I. The action of *B. subtilis* and *B. mesentericus* on certain sugars to form levan, a colloidal viscous substance which has been a source of trouble to sugar manufacturers, and is related in its structure to inulin.

II. The action of *Leuconostoc mesenterioides* and *L. dextranicus* on cane sugar to form dextran, a viscous stringy substance present in pulka.

III. The action of *Acetobacter xylinus* on various carbohydrates and related compounds to form synthetic cellulose.

These investigations may increase our knowledge of the mechanism of plant metabolism, the action of polysaccharides in immunology and the production of chemicals by fermentation. Attempts are being made to obtain a bacteria-free levan enzyme.

During the year the structure of dextran was examined and it was found to be a polymerized glucose anhydride as well as a polymerized trisaccharide. Its exact constitution has not yet been established, but there are indications that it contains a furanose ring, relating it to blood sugar. The antigenic action of dextran, previously recorded was found to disappear when the nitrogen content was reduced to 0.1% or less. Whether the antigenic action was due to the colloid on which the dextran was adsorbed or whether dextran becomes antigenic when adsorbed on a colloid is being investigated.

The synthesis of cellulose from starting materials other than sugars, for example formaldehyde, is being attempted.

The properties of levans synthesized from sucrose and raffinose are being compared.

(Investigation under the direction of Dr. H. Hibbert, McGill University.)

Spectroscopy and Atomic Structure

Co-operating organizations:

University of Alberta
German National Physical Laboratory

The metal indium, which owes its name to the blue lines which led to its discovery through the spectroscope, only last year became available in commercial quantities. A study of its higher spectra is therefore of practical interest.

In order to get the first spark lines with sufficient intensity, it was necessary to excite the spectrum in a hollow cathode in the presence of neon. About 125 lines in the region between 500 and 8000 Å were measured and

arranged according to the theoretical system so that the spectrum is now known about as completely as that of the more abundant related elements gallium and aluminium.

Published paper:

Lang, R. J. and Sawyer, R. A. Das erste Funkenspektrum des Indiums.

(Investigation under the direction of Prof. R. J. Lang, University of Alberta.)

Spectroscopy in the Ultra-violet

Co-operating organization:

University of Alberta

When in an electrical discharge through lead vapor one negative charge is removed from the lead atom, the spectrum of the ion thus obtained resembles that of thallium except that all the frequencies are much higher; when two charges are removed the system of spectral lines should duplicate that of mercury, and, with three electrons gone, that of gold. It is of interest to study these changes.

While nearly 100 different wave-lengths corresponding to about 20 different energy levels of the atoms have been established in the case of both the neutral lead and singly ionized lead atom, it has been possible to chart only about 20 lines as belonging to doubly ionized lead, Pb III. Much work has been done on discharges capable of giving a distinct Pb III spectrum with sharp lines. The most promising source found has been the light inside a hollow lead cathode in helium with a rotating gap in series with the discharge tube and condenser of large capacity, about one microfarad, shunted across the gap and tube.

Work on the spectrum of Bi IV is also in progress.

Published paper:

Smith, Stanley. The Resonance Potential of Trebly Ionized Bismuth. Nature, 127: 855. 1931.

(Investigation under the direction of Professor Stanley Smith, University of Alberta.)

Effect of Light on Life Processes

Co-operating organization:

Queen's University

It cannot be denied that the sea and its products are of enormous value to Canada. When it is further realized that the rate of growth of organisms and the species found in a given marine situation are to a considerable extent controlled by the nature and amount of light in that environment, the value of investigations on the effect of light on aquatic organisms can readily be seen.

During the past year it has been shown in this investigation that the edible sea-weed, dulse, thrives best under green light, thus accounting for its distribution at and below low-tide level.

It has also been found, in collaboration with C. L. Newcombe, M.A., that light tends to prevent the growth of barnacles on a dock.

Preliminary work has been started on the effect of light on diatoms. These minute unicellular organisms are of great importance in that they comprise the food of the organisms eaten by fish. It is hoped to obtain considerable knowledge of the conditions of growth of diatoms.

An apparatus has been developed to measure light intensity under water by photographic means, and the effects of various waters, sea, lake, pond, etc., on the intensity and quality (color) of light passing through them have been investigated.

Finally, the influence of the myriads of free living microscopic organisms in natural waters upon the amount of light passing through the water is being studied.

(Investigation under the direction of Dr. A. Brooker Klugh, Queen's University.)

The Effect of Radiant Energy on Enzyme Action

Co-operating organization:

University of British Columbia

In recent years the importance of radiant energy, particularly that in the visible and ulta-violet regions of the spectrum, has become increasingly recognized in the field of medicine. However, inasmuch as energy of different wave-lengths often exhibits strikingly different effects on protoplasm, enzymes, etc., it is of great importance that the wave-lengths of the radiant energy used in a particular case be such as will produce the desired effect. That is to say, if all destruction is desired, the wave-lengths used should not contain any that are beneficial to all growth and *vice versa*. This matter has not always been given due attention in the past.

The series of experiments carried out during recent years on the effect of radiant energy on plant and animal protoplasm aims at discovering the effects of specific wave-lengths upon living organisms, especially the animal organism, and at attempting to ascertain the basic changes involved in these effects, so that the findings may be intelligently applied.

It has been found in this investigation that the starch soluble activity of salivary and malt diastase are reduced by the action of light from a mercury arc lamp in relation to the intensity, but that the monochromatic lines of the mercury arc spectrum have either a stimulatory or inhibitory action; the shorter wave-lengths showing the greater inhibition. Malt diastase, however, is noticeably affected by four lines of the mercury arc spectrum only, and with a decided inhibitory effect. There are indications that plant diastase is less sensitive to light from a mercury arc lamp than is animal diastase. Work is at present being carried out on the effect of light on the sugar-reducing component of the diastases used.

There also appears to be some correlation between the effect of monochromatic light on the growth of paramecium and on the activity of salivary diastase.

The results obtained with oxidase of potato juice show that a stimulatory effect is obtained in the total visible portion of the spectrum and a decidedly inhibitory one in the near ulta-violet and far ultra-violet; these results were verified when monochromatic lines were used.

(Investigation under the direction of Dr. A. H. Hutchinson, University of British Columbia.)

APPENDICES

APPENDIX A

52 Scholarships held during the year 1931-1932

FELLOWSHIPS

Grantee	Graduated	Where Held	Subject of Research
Alan C. Burton.....	B.Sc., University of London; M.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	High-frequency electromagnetic waves and their application to medicine and to other fields of research.
Gordon F. Frame.....	B.A., M.A., Dalhousie University.	Department of Chemistry, McGill University, Montreal, Que.	Certain reactions of γ-ketonic nitriles and esters.
E. P. Linton.....	B.Sc., Mount Allison University; M.Sc., McGill University.	Department of Physical Chemistry, McGill University, Montreal, Que.	The determination of the temperature coefficient of the dielectric constant of water.
F. H. Peto.....	B.S.A., University of Manitoba; M.Sc., University of Alberta.	Department of Cytology, University College of Wales, Aberystwyth.	A study of meiosis and mitosis in certain *lolium* and *festuca* species.
H. D. Smith.....	B.A., M.A., University of British Columbia; M.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	Changes in the magnetic and optical properties of various metals and liquefied gases.

STUDENTSHIPS

Grantee	Graduated	Where Held	Subject of Research
J. F. Allen.....	B.A., University of Manitoba; M.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	The nature of the phenomenon of superconductivity.
J. M. Armstrong.....	B.Sc., University of Saskatchewan.	Department of Genetics, McGill University, Montreal, Que.	Cytology and genetics of Matthiola incana.
J. Campbell.....	B.A., University of Toronto.	Department of Biochemistry, University of Toronto, Toronto, Ont.	Synthesis by the proteolytic tissue enzymes.
Miss M. Campbell.....	B.A., M.A., University of British Columbia.	Department of Zoology, University of Toronto, Toronto, Ont.	Life history of two copepods, *Colanus tonsus* Brady and *Euchaeta japonica* Marukawa.
H. M. Chisholm.....	B.Sc., Dalhousie University.	Department of Applied Mathematics, University of Toronto, Toronto, Ont.	Hydrodynamics of viscous fluids.
Miss M. E. Greig.....	B.A., McGill University; M.A., University of Saskatchewan.	Department of Cellulose Chemistry, McGill University, Montreal, Que.	Mechanism of acyl migration in organic compounds.
G. W. Gurd.....	B.A., M.A., University of Western Ontario.	Department of Physical Chemistry, McGill University, Montreal, Que.	The investigation of equilibria existing in aqueous solutions of sulphur dioxide and other soluble gases.
E. G. Hallonquist.....	B.A., M.A., University of British Columbia.	Department of Cellulose Chemistry, University of McGill, Montreal, Que.	Synthesis and properties of cyclic and bicyclic acetols.
R. N. H. Haslam.....	B.A., M.A., University of Saskatchewan.	Department of Physics, McGill University, Montreal, Que.	The Stark effect in the spectra of metals.

Grantee	Graduated	Where Held	Subject of Research
J. F. Heard	B.A., University of Western Ontario; M.A., McGill University.	Department of Physics, McGill University, Montreal, Que.	The Stark effect in complex spectra.
Miss E. M. Hearne	B.A., M.A., Queen's University.	Department of Genetics, McGill University, Montreal, Que.	Genetics of cereal hybrids and cytological investigations on grasshoppers.
F. T. Jolliffe	B.A., M.A., Queen's University.	Department of Geology, Queen's University, Kingston, Ont.	A study of greenalite.
M. K. McPhail	B.A., University of British Columbia.	Department of Biochemistry, McGill University, Montreal, Que.	The pituitary and its relation to sex physiology.
F. L. Munro	B.A., M.A., University of British Columbia.	Department of Physical Chemistry, McGill University, Montreal, Que.	The relationship between particle size and light absorption.
S. Z. Perry	B.Sc., M.Sc., McGill University.	Department of Organic Chemistry, McGill University, Montreal, Que.	Synthesis and properties of polyethylene glycols, polyethylene oxides and the nature of polymerization.
W. B. Ross	B.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	(1) Supersonic sound phenomena; (2) Electrical measurements.
H. R. Sallans	B.Sc., University of Saskatchewan.	Department of Organic Chemistry, McGill University, Montreal, Que.	Reactions of 1, 5-diketones.
H. H. Saunderson	B.A., B.Sc., M.Sc., University of Manitoba.	Department of Physical Chemistry, McGill University, Montreal, Que.	Penetration of acid solutions into spruce.
W. W. Stewart	B.Sc., Dalhousie University.	Department of Physical Chemistry, McGill University, Montreal, Que.	The viscosity of gases.
R. Turnbull	B.A., M.A., University of Toronto.	Department of Physics, University of Toronto, Toronto, Ont.	Changes in absorption spectra related to change of state.
A. R. Williams	B.Sc., M.Sc., Queen's University.	Department of Physical Chemistry, McGill University, Montreal, Que.	Surface energy of sulphur.
C. A. Winkler	B.Sc., M.Sc., University of Manitoba.	Department of Physical Chemistry, McGill University, Montreal, Que.	A study of gaseous reactions at high temperatures and pressures.

BURSARIES

Grantee	Graduated	Where Held	Subject of Research
H. M. Barrett	B.A., M.A., University of Toronto.	Department of Physical Chemistry, University of Toronto, Toronto, Ont.	Adsorption of vapors by solids.
S. Bateson	B.Sc., Dalhousie University.	Department of Physics, Dalhousie University, Halifax, N.S.	Study of pleochroic haloes in mica.
R. M. Beatty	B.A., University of New Brunswick.	Department of Physical Chemistry, University of Toronto, Toronto, Ont.	Sour taste of acids.
J. F. Caley	B.Sc., M.Sc., University of Alberta; M.A., University of Toronto.	Department of Geology, University of Toronto, Toronto, Ont.	The Ordovician succession in northeastern part of Manitoulin Island, Ontario.
A. M. Crooker	B.A., McMaster University.	Department of Physics, University of Toronto, Toronto, Ont.	The Zeeman effect of hyperfine structure.
G. S. Farnham	B.A., Queen's University.	Department of Metallurgy, Queen's University, Kingston, Ont.	The electrolytic refining of cobalt and the study of cobalt tungsten chromium alloys.

Grantee	Graduated	Where Held	Subject of Research
K. R. Gray.....	B.A., University of British Columbia.	Department of Organic Chemistry, McGill University, Montreal, Que.	Structure of lignin.
W. A. F. Hagborg.....	B.S.A., University of Manitoba.	Dominion Rust Research Laboratory, Winnipeg, Man.	Determination of the etiology of a disease attacking rust resistant wheat.
G. A. Harcourt.....	B.Sc., University of Alberta.	Department of Geology, Queen's University, Kingston, Ont.	Determination and distribution of the minor elements in the chemical composition of certain igneous rocks.
Miss J. F. L. Hart.....	B.A., University of British Columbia.	Department of Zoology, University of Toronto, Toronto, Ont.	Early life history of certain *Brachyura* and *Anomura*.
O. K. Johannson.....	B.A., University of Saskatchewan.	Department of Chemistry, University of Saskatchewan, Saskatoon, Sask.	Determination of thermochemical constants for compounds in the system CaO, Al_2O_3–SiO_2.
N. B. Keevil.....	B.Sc., University of Saskatchewan.	Department of Chemistry, University of Saskatchewan, Saskatoon, Sask.	Hydrolysis of the compounds occurring in Portland cement.
A. Labrie.....	B.A., L.ès Sc., Laval University.	Department of Biochemistry, Laval University, Quebec, Que.	Aromatic substance of maple products.
Miss E. M. Lyons.....	B.Sc., M.Sc., University of Manitoba.	Department of Biology, University of Toronto, Toronto, Ont.	Cestodes of fresh-water fishes of Ontario and Quebec.
R. D. McDonald.....	B.Sc., Queen's University.	Department of Physical Chemistry, Queen's University, Kingston, Ont.	Catalytic effect of oxide mixtures on the rates of reactions between the hydrocarbons and steam.
D. W. McLauchlan.....	B.Sc., Mount Allison University.	Department of Physical Chemistry, McGill University, Montreal, Que.	Hydrogen peroxide—methyl ether mixtures.
L. S. Macklin.....	B.Sc., University of Manitoba.	Department of Physical Chemistry, McGill University, Montreal, Que.	A study of the penetration of cooking liquors into wood: the influence of temperature, concentration, rate of circulation, time, etc.
H. B. Marshall.....	B.A., M.A., University of British Columbia.	Department of Organic Chemistry, McGill University, Montreal, Que.	Synthesis and structure of polysaccharides obtained by bacterial action on carbohydrates.
E. E. Massey.....	B.A., Bishop's University.	Department of Organic Chemistry, McGill University, Montreal, Que.	Delta-ketonic esters.
A. S. Ross.....	B.A., University of Western Ontario.	Department of Physical Chemistry, McGill University, Montreal, Que.	An investigation of the equilibria existing in aqueous solutions of chlorine.
H. L. Sandford.....	B.A.Sc., University of Toronto.	Department of Chemistry, University of Toronto, Toronto, Ont.	The nature of the intermediate compounds formed in producing the active catalyst for the reduction of SO_2 by H to elementary sulphurs.
A. H. Snell.....	B.A., University of Toronto; M.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	Stark effect in some molecular spectra.
R. L. Thornton.....	B.Sc., McGill University.	Department of Physics, McGill University, Montreal, Que.	Asymmetry in the intensities of the Stark components of the Balmer series in hydrogen.
S. M. Trister.....	B.Sc., McGill University.	Department of Cellulose Chemistry, McGill University, Montreal, Que.	Synthesis and structure of cyclic acetals and related compounds.
J. H. L. Truscott.....	B.Sc., M.Sc., University of Saskatchewan.	Department of Plant Pathology, University of Toronto, Toronto, Ont.	A study of soil borne parasitic Pythiaceous fungi.

APPENDIX B

Researches in Progress During 1931-32 Under Associate Committees and Under Grants in Aid of Research

Subject of Research	Directed By	Co-operating Organizations
The utilization of Canadian high magnesium dolomite	Associate Committee on Magnesian Products	Federal Department of Mines, Ottawa; Canadian Refractories Ltd.
Damage caused by smoke fumes from the Trail smelters	Associate Committee on Trail Smelter Smoke	British Columbia Department of Agriculture; Federal Department of Agriculture; Federal Forest Service.
Problems of the grain industry.....	Associate Committee on Grain Research	Board of Grain Commissioners, Winnipeg; University of Manitoba; University of Alberta; University of Saskatchewan; Macdonald College.
Tuberculosis in man and animals...	Associate Committee on Tuberculosis	Department of Bacteriology, University of Alberta; Department of Pathology and Bacteriology, University of Toronto; Department of Bacteriology, Queen's University; Faculty of Medicine, University of Montreal; Queen Alexandra Sanatorium, London, Ont. Fort Qu'Appelle Sanatorium, Fort San, Sask; Federal Department of Agriculture.
Problems of the wool industry.....	Associate Committee on Wool	Dominion Department of Agriculture; University of Alberta; University of Saskatchewan.
Chemical control of weeds.....	Associate Committee on Weed Control	University of Alberta; University of Saskatchewan; University of Manitoba.
Diseases of animals.....	Associate Committee on Animal Diseases	University of Montreal; University of British Columbia; Macdonald College.
Engineering standardization.....	Associate Committee on Engineering Standards	
Foot- and root-rot diseases of crop plants	Associate Committee on Field Crop Diseases	University of Alberta; University of Manitoba; University of Saskatchewan; Federal Department of Agriculture.
Problems of the asbestos industry...	Associate Committee on Asbestos	Canadian Asbestos Producers and Manufacturers; Dominion Department of Mines; Quebec Bureau of Mines.
Problems of the leather industry....	Associate Committee on Leather	British Leather Manufacturers' Research Association; Tanners Section, Toronto Board of Trade; Technical Association of Canadian Leather Belting Manufacturers.
Problems of the laundry industry...	Associate Committee on Laundry Research	Eastern Canadian Laundryowners Association.
Electrical measuring instruments....	Associate Committee on Electrical Measuring Instruments	Department of Trade and Commerce.
Heating and insulation of buildings..	Associate Committee on Heating and Insulation	Dominion Fuel Board; McGill University; Queen's University; University of Saskatchewan; University of Toronto.
Investigations in connection with the total eclipse of the sun in 1932	Associate Committee on Radio	Canadian Marconi Compan McGill University; Northern Electric Compan
Standardization of classification and analysis of coal	Associate Committee on Coal Classification and Analysis	University of Alberta.

Subject of Research	Directed By	Co-operating Organizations
Natural gas	Associate Committee on Gas Research	University of Alberta; University of Toronto.
Problems of the honey industry	Associate Committee on Honey	Dominion Department of Agriculture; Manitoba Agricultural College; Montreal District Beekeepers Association.
Utilization of Canadian iron ores	Subcommittee on Iron Ores of the Associate Committee on Metallurgy	Steel Company of Canada, Hamilton.
Barley *versus* corn as a food for poultry	Prof. M. C. Herner	Department of Poultry Husbandry, Manitoba Agricultural College, Winnipeg, Man.
Pressure variations inside the cylinders of the internal combustion engine	Dr. D. A. Keys	Department of Physics, McGill University, Montreal, Que.
Wireworms and false wireworms	Prof. E. H. Strickland	Department of Entomology, University of Alberta, Edmonton, Alta.
The action of alkali on cement and concrete	Prof. T. Thorvaldson	Department of Chemistry, University of Saskatchewan, Saskatoon, Sask.
Raman effect	Dr. A. S. Eve	Department of Physics, McGill University, Montreal, Que.
Emission and absorption spectra in the infra-red and extreme ultra-violet region	Prof. J. C. McLennan	Department of Physics, University of Toronto, Toronto, Ont.
Effect of radiant energy on protoplasm	Prof. A. H. Hutchinson	Department of Botany, University of British Columbia, Vancouver, B.C.
Continuity of welded steel beams	Prof. C. R. Young	Mechanics of Materials Laboratory, University of Toronto, Toronto, Ont.
Surface energy of solids	Prof. F. M. G. Johnson and Dr. O. Maass	Department of Chemistry, McGill University, Montreal, Que.
Plant resources of eastern Canada	Prof. Marie-Victorin	Department of Botany, University of Montreal, Montreal, Que.
1. Physical and chemical oceanography 2. Marine biology 3. Fish technology	Dr. C. McLean Fraser	University of British Columbia; Biological Board of Canada; Dominion Meteorological Service.
Studies on humidity	Prof. A. N. Shaw	Department of Physics, McGill University, Montreal, Que.
The effect of light on life processes	Prof. A. B. Klugh	Department of Biology, Queen's University, Kingston, Ont.
Experiments on the preparation of anthraquinone vat dyes	Dr. Paul E. Gagnon	Department of Chemistry, Laval University, Quebec, Que.
Effects of electric and magnetic fields	Prof. J. S. Foster	Department of Physics, McGill University, Montreal, Que.
Investigation of gas laws	Dr. O. Maass	Department of Chemistry, McGill University, Montreal, Que.
The marine algae of the Canadian Atlantic coast	Prof. H. P. Bell	Department of Botany, Dalhousie University, Halifax, N.S.
Fungi	Prof. A. H. R. Buller	Department of Botany, University of Manitoba, Winnipeg, Man.
Mechanical properties of metals at low temperatures	Profs. I. F. Morrison and A. E. Cameron	Department of Mining Engineering, University of Alberta, Edmonton, Alta.
Ultra-violet spectroscopy with vacuum grating spectrograph	Dr. R. J. Lang and Prof. S. Smith	Department of Physics, University of Alberta, Edmonton, Alta.
Nervous actions underlying color vision and all sensory activities	Dr. F. Allen	Department of Physics, University of Manitoba, Winnipeg, Man.
Electrostatic studies on milk and milk products	Prof. H. R. Thornton	Department of Dairying, University of Alberta, Edmonton, Alta.
The spectrum of the aurora and the light from the sky and its bearing on radio transmission	Prof. J. C. McLennan	Department of Physics, University of Toronto, Toronto, Ont.
Power loss in dielectrics	Dr. H. J. MacLeod	Department of Physical and Electrical Engineering, University of Alberta, Edmonton, Alta.

Subject of Research	Directed By	Co-operating Organizations
Cytological and histological investigations of alfalfa and clover	Prof. W. P. Thompson	Department of Biology, University of Saskatchewan, Saskatoon, Sask.
Chemical problems of the maple sugar industry	Dr. J. F. Snell	Department of Chemistry, Macdonald College, Quebec.
Mineral deficiency of Quebec soils	Dr. R. R. McKibbin	Department of Chemistry, Macdonald College, Quebec.
Study of short radio waves	Prof. J. C. McLennan	Department of Physics, University of Toronto, Toronto, Ont.
The conversion of starch to glucose	Prof. E. G. Young	Department of Biology, Dalhousie University, Halifax, N.S.
Wind tunnel automatic speed control equipment	Prof. H. W. Price	Department of Electrical Engineering, University of Toronto, Toronto, Ont.
Unsaturated hydrocarbons as a source of chemical products	Dr. O. Maass	Department of Chemistry, McGill University, Montreal, Que.
Studies of life in the Pacific adjacent to the Fraser River	Prof. A. H. Hutchinson	Pacific Biological Station, Nanaimo, B.C.
Ultra-violet spectroscopy	Prof. S. Smith	Department of Physics, University of Alberta, Edmonton, Alta.
The life cycle of fish tapeworm	Dr. D. Nicholson	Department of Pathology, University of Manitoba, Winnipeg, Man.
The lateral support of steel columns and struts	Prof. C. R. Young	Mechanics of Materials Laboratory, University of Toronto, Toronto, Ont.
Relation of bacteria to incidence of feed flavors and stable odors in milk	Profs. H. M. King and W. Sadler	Department of Animal Husbandry, University of British Columbia, Vancouver, B.C.
The uses of photo-electric cell	Prof. A. Savage	Animal Pathology Laboratory, Manitoba Agricultural College, Winnipeg, Man.
Action of bacteria and enzymes on carbohydrates and products resulting therefrom	Dr. H. Hibbert	Department of Chemistry, McGill University, Montreal, Que.
Investigations on gas and water content of trees	Prof. R. D. Gibbs	Department of Botany, McGill University, Montreal, Que.
Microbiology of soil conditions in eastern Canada	Prof. P. H. H. Gray	Department of Bacteriology, Macdonald College, Que.
Mineral constituents of the floral parts and young fruits of the apple	Prof. W. A. DeLong	Department of Chemistry, Acadia University, Wolfville, N.S.
Parasites of the snowshoe rabbit	Prof. R. A. Wardle	Department of Zoology, University of Manitoba, Winnipeg, Man.
Indirect ultra-violet solar radiation and its distribution	Prof. R. C. Dearle	Department of Physics, University of Western Ontario, London, Ont.
The bark disease of the beech	Mr. Otto Schierbeck	Field work in forests of Nova Scotia.
Status of slough itch in Saskatchewan	Prof. L. G. Saunders	Department of Biology, University of Saskatchewan, Saskatoon, Sask.
Design and construction of appaatus for interpreting print, by touch, through the medium of the photo-electric cell	Dr. Frank Allen	Winnipeg, Man.

APPENDIX B (Part II)

Additional Researches Carried Out in Previous Years

Subject of Research	Grantee
The inheritance of earliness and lateness in wheat	Dr. W. P. Thompson.
Water requirements of crops in western soils	E. S. Hopkins.
The relation of bacteria to the quality of graded butter	Prof. W. Sadler.
Fungi	Dr. A. H. R. Buller.
Acidity and lime requirements of soils in Quebec and New Brunswick	Dr. J. F. Snell.
The influence of acid in the soil on useful (nitrogen fixing) bacteria	Dr. F. C. Harrison.
Insulin-like substances in plants	Dr. J. B. Collip.
Action of pure salts on the structure and growth of vegetable cells	Prof. G. W. Scarth.
The influence of diet on the fur and health of captive foxes	Associate Committee on Nutritional Problems of the Fox Industry.
The resistance of plants to low temperatures	Prof. J. F. Lewis.
The biological origin of false wild oats	Prof. J. R. Fryer.
Life history and habits of the Tabanidae (horsefly)	Prof. A. E. Cameron.
Study of the blood chemistry in animals with the super renal glands removed	Prof. J. B. Collip.
Investigation of the life history of the onion maggot	Prof. E. M. DuPorte.
The use of Canadian oils in ore concentration	Dr. J. B. Porter.
The extraction of benzene and toluene (valuable liquids) from coal gas	Dr. H. S. Davis.
De-tarring of gas by electrical precipitation	Dr. J. G. Davidson.
Reduction of iron ores by gases	Dr. A. Stansfield.
A method of smelting titaniferous iron ores	Dr. C. W. Drury and A. F. G. Cadenhead.
The testing of oil shales in the field	Louis Simpson.
The treatment of silver-lead-zinc ores	Horace Freeman.
The preparation (production) of metallic barium	Prof. H. E. Bigelow.
Oil from shales	Prof. A. E. Flynn.
Alberta tar sands	Dr. A. Lehmann.
Lake Agassiz clay deposits	Prof. R. C. Wallace.
The microscopic examination of cement during hardening	F. M. Dawson.
Causation of cracks in concrete protective coating on iron and steel structures	Prof. P. Gillespie.
The corrosion of iron and steel in the soil	Prof. J. W. Shipley.
Investigation on the utilization of the resources of helium in Canada	Associate Committee on Helium.
The properties and liquefaction of helium	Prof. J. C. McLennan.
Canadian waste sulphite liquor as a source of alcohol	Dr. V. K. Krieble.
The discoloration of cured codfish	Dr. F. C. Harrison.
The discoloration of canned lobster	Dr. F. C. Harrison.
Artificial propagation of the sturgeon	Associate Biological Committee.
The food relations of certain minute organisms (Entomostraca) in the cultivation of fresh water fishes	Prof. A. B. Klugh.
Bacteria found in frozen fish	Dr. F. C. Harrison.
Nicotine from tobacco waste	Arthur D. Hone.
Utilization of milkweed	Dr. A. C. Neish.
Problems of industrial fatigue	Associate Committee on Industrial Fatigue.
The utilization of peat	Department of Mines.
Channel interference in wind channel testing	Prof. J. H. Parkin.
Interference in radio broadcast reception	Prof. T. R. Roseburgh.
Fog signalling	Prof. L. V. King.
Vitamines	Food Research Committee.
Surface tension in liquids and emulsions	Prof. J. C. McLennan.
Chemical reactions at high pressures	Prof. J. C. McLennan.
Conductivity and vapor pressure of salt solutions	Prof. A. N. Shaw.
Crystalline shapes of bicarbonate of soda	Prof. Paul Riou.
Investigation on Röntgen rays	Dr. J. A. Gray.
The bridging of the gap in the ether waves between those produced by the ultra-violet light and the so-called X-rays	Prof. A. L. Hughes.
The spectrum of infra-red rays	Prof. J. C. McLennan.
The action of ultra-violet rays	Prof. L. Bourgoin.
Intensity measurements in spectra	Prof. J. K. Robertson.
The spectrum of tin	Prof. J. K. Robertson.
Constitution of rubber	Dr. G. S. Whitby.
Generation of explosive gases in electric water heaters and boilers	Dr. J. W. Shipley.
The breeding efficiency of bulls and horses	Dr. A. Savage.
Experimental study of precipitation of iron and silica	Dr. E. S. Moore.
Cultivation of medicinal plants in British Columbia	Dr. R. H. Clark and Prof. J. Davidson.
Laws governing the screening of crushed ores	Dr. J. B. Porter.
Grinding ore in ball mills and rock crushing by rolls	Prof. H. E. T. Haultain.
Determining the elimination of magneto noises from aircraft receiving sets	Prof. H. Vickers.
Storage of fruit in warehouses	Associate Committee on Fruit.
Use of ultra short waves for direction indicating apparatus	Lieut.-Col. W. A. Steel.
Radium emanation	Dr. G. H. Henderson and Dr. D. A. McIntosh.
Dielectric losses in different classes of porcelain	Prof. A. V. Wendling.
Relation of silver ores to diabase	Dr. E. S. Moore.
Magnetic susceptibility of the alkali metals	Dr. A. S. Eve.

Subject of Research	Grantee
Chemical separation, identification and possible synthesis of antipressor substance from hepatic tissue	Dr. A. A. James.
Structure and growth of anchor ice	Dr. H. T. Barnes.
Effects of velocity on re-absorption rates	Prof. O. S. Gibbs.
Effect of ultra-violet rays on eggs, chicks and laying hens	F. C. Elford.
Adhesion of ice to various surfaces of aeroplane structure	Dr. H. T. Barnes.
Sound analysis of carillon on Peace Tower	Prof. E. F. Burton.
The active principle of yeast	Prof. W. L. Miller.
Factors governing the milling and baking quality of wheat	Dr. R. Newton.
Ultrasonics (inaudible sound waves)	Dr. R. W. Boyle.
Bacillary white diarrhoea in poultry	Prof. H. W. Hill and Prof. E. A. Lloyd.
Rotary derivatives of a boat type seaplane	Prof. J. H. Parkin.
Fog alarm research	Dr. L. V. King.
Glucosides of plants indigenous to western Canada	Prof. A. T. Cameron.
The habit and life history of the smaller mammals of the prairies	Mr. F. Neave.
Mistletoe, parasitic on jack pine	Miss E. S. Dowding.
Winter hardiness in crop plants	Dr. R. Newton.
The chemistry of fish curing	Dr. A. B. Macallum.
Researches in the field of low temperatures	Prof. J. C. McLennan.
Chlorination of methane gas	Prof. M. C. Boswell.
Designing and testing of a series of windmills for producing electric power on farms	Prof. J. H. Parkin.
Cause of the reversed blood pressure of fowls	Prof. O. S. Gibbs.
Experiments on catalysis	Prof. G. S. Whitby.
Best methods for obtaining accurate results in testing varieties, strains and treatments of grain	Associate Committee on Accurate Plot Work.
Reforestation experiments on cut-over and burnt-over lands	Associate Committee on New Brunswick Forest Problems.
Health hazards in spray painting	Associate Committee on Spray Painting.
The problem of slack barrels in apple exports	Associate Committee on Apple Slacks.
Destruction of wood piling by marine boring animals	Associate Biological Committee.
The inheritance of sugar and starch in Indian corn	Prof. H. F. Roberts.
Generation of electricity using a windmill as the prime mover	Prof. A. R. Greig.
Effects of certain reagents upon plants	Prof. R. O. Earl.
The effect of temperature and fatigue on the strength of castings	Prof. R. W. Moffatt.
The deterioration of rubber	Dr. G. S. Whitby.
Earth's nocturnal radiation in relation to weather	Dr. H. T. Barnes.
Cathode rays	Dr. J. A. Gray.
Development of a rapid electrical method of determining moisture in grain, timber, etc	Prof. E. F. Burton.
Investigation and preparation of yeast spores	Prof. W. L. Miller.
Measurement of the Joule effect of hydrogen, carbon dioxide and other gases	Dr. A. L. Clark.

APPENDIX C

Publications of the National Research Council

Annual Reports

Annual Reports for fiscal years 1916-17 to 1931-32.

Monthly Publication

Canadian Journal of Research
From May 1, 1929, to date
Two volumes annually

Technical Reports

Report Number	Title	Author
1.	The Briquetting of Lignites	R. A. Ross, E.E., D.Sc., 1918.
2.	The Recovering of Vapors from Gases	Harold S. Davis, M.A., Ph.D., and Mary Davidson Davis, B.A., 1918.
3.	The De-tarring of Gas by Electrical Precipitation. (Out of print)	J. G. Davidson, Ph.D., 1918.
4.	Nicotine and Tobacco Waste. (Out of print)	A. D. Hone, M.A., 1919.
5.	Canadian Waste Sulphite Liquor as a Source of Alcohol	V. K. Krieble, 1919.
6.	An Investigation into the Question of Early Putrefaction of Eviscerated Fish in which the Gills have been Left	L. Gross, M.A., 1919.
7.	Survey of General Conditions of Industrial Hygiene in Toronto	The Associate Committee on Industrial Fatigue of the National Research Council, 1921.
8.	A Method of Smelting Titaniferous Iron Ore	W. M. Goodwin, 1921.
9.	Food Requirements of the Ranch Fox	G. E. Smith, B.A.Sc., 1921.
10.	Fuel Saving Possibilities in House Heating	L. M. Arkley and James Govan, 1922.
11.	The Red Discoloration of Cured Codfish	F. C. Harrison, D.Sc., F.R.S.C., and Miss Margaret E. Kennedy, B.A., M.Sc., 1922.
12.	The Discoloration, Smut or Blackening of Canned Lobster	F. C. Harrison, D.Sc., F.R.S.C., and E. G. Hood, Ph.D., 1923.
13.	Cultural Criteria for the Distinction of Wood-destroying Fungi	Clara W. Fritz, B.A., M.Sc., 1924.
14.	The Utilization of the Low Grade Iron Ores of Canada	Subcommittee on Iron Ores of the National Research Council, J. G. Morrow, Steel Company of Canada, Hamilton, Ontario, Chairman, 1924.
15.	Marine Borers on the Atlantic Coast of Canada	R. H. M'Gonigle, B.A., 1925.
16.	The Relation of Bacteria to the Quality of Graded Butter	Wilfred Sadler, N.D.D., B.S.A., M.Sc., and R. L. Vollum, M.A., 1926.
17.	The Mosquitoes of the Lower Fraser Valley, British Columbia, and their Control	Eric Hearle, M.Sc., 1926.
18.	Investigations on the Treatment of Nova Scotia Oil Shales	A. E. Flynn, A.R.S.M., 1926.
19.	Bacteriology of Certain Sea Fish	F. C. Harrison, D.Sc., F.R.S.C., 1926.
20.	Consideration of the Relation between the Distribution of Teredo Navalis and Temperature and Salinity of its Environment	R. H. M'Gonigle, B.A., 1926.
21.	The Life History of Exeristes Roborator Fab., a Parasite of the European Corn Borer	J. H. Fox, M.A., 1927.
22.	An Experimental Study of Sieving	J. B. Porter, Ph.D., D.Sc., 1928.
23.	The Storage of Apples in Air-cooled Warehouses in Nova Scotia	S. G. Lipsett, Ph.D., 1928.
24.	The Drying of Wheat	Associate Committee on Grain Research, 1929.

BULLETINS

Bulletin Number	Title	Author
1.	The Need of Industrial Research in Canada	Frank D. Adams, Sc.D., LL.D., F.R.S., 1918.
2.	Researches on Sound Measurement with Reference to the Testing of Fog Signal Machinery	L. V. King, M.A., D.Sc., F.R.S.C., 1918.
3.	How to Handle Frozen Fish. (Out of Print)	E. E. Prince, D.Sc., LL.D., 1918.
4.	Hints on Frozen Fish. (Out of Print)	E. E. Prince, D.Sc., LL.D., 1918.
5.	Science and Industry	Prof. J. C. Fields, Ph.D., F.R.S., 1918.
6.	The Heating of Houses, Coal and Electricity Compared. (Out of Print)	A. S. L. Barnes, 1918.
7.	The Manufacture of Ethyl Alcohol from Wood Waste. (Out of Print)	G. H. Tomlinson, B.A., 1919.
8.	Some of the Problems of the Fox Raising Industry. (Out of Print)	Andrew Hunter, M.A., M.B., Ch.B. (Edin.), 1920.
9.	The Honorary Advisory Council for Scientific and Industrial Research and its Work. A Brief Résumé of the Activities of the Council up to 1921. (Out of Print)	Frank D. Adams, Sc.D., LL.D., F.R.S., 1921.
10.	A Plan for the Development of Industrial Research in Canada	R. F. Ruttan, B.A., M.D., F.R.S.C., 1921.
11.	Nitrogen Fixation. (Out of Print)	Nitrogen Fixation Committee, Prof. J. C. McLennan, Chairman, 1924.
12.	Nitrogen in Industry	Nitrogen Fixation Committee, Prof. J. C. McLennan, Chairman, 1926.
13.	Interim Report on Protein Content as a Factor in Grading Wheat	Associate Committee on Grain Research, 1929.
14.	Report on Inquiry in Europe Regarding the Feasibility of Using Protein Content as a Factor in Grading and Marketing Canadian Wheat	R. Newton, Ph.D., F.R.S.C.
15.	Review of Literature Dealing with Health Hazards in Spray Painting	Prepared under the Auspices of the Associate Committee on Spray Painting.

APPENDIX D

Publications ot the Canadian Engineering Standards Association

(The National Research Council's Associate Committee on Engineering Standards)

No.

A 1—1928 Standard Specification for Steel Railway Bridges. (third edition) Price 50c
A 1a—1928 Material Specifications, Steel Railway Bridges. (second reprint) Price 15c
C 2—1929 Standards for Single-phase Distribution Transformers. (second edition)
C 3—1924 Standard Specification for Galvanized Telegraph and Telephone Wire.
B 4—1921 Standard Specification for Wire Rope for Mining, Dredging and Steam Shovel Purposes. (Under revision)
A 5—1927 Standard Specification for Portland Cement. (second edition)
A 6—1929 Standard Specification for Steel Highway Bridges. (second edition) Price 50c
D 7—1922 Standard Specification for Flexible Steel Wire Rope and Strand for Aircraft Purposes.
G 8—1923 (Replaced by G26–1929 and G27–1929. See below.)
A 9—1923 (Replaced by G30–1930, G31–1930 and G32–1930. See below.)
C 10—1923 Standard Specification for Tungsten Incandescent Lamps.
D 11—1924 Interim Report on the Manufacture, Testing and Use of Gasoline, with Notes on Lubricating Oil.
B 12—1924 Standard General Specification for Galvanized Steel Wire Strand.
E 13—1924 Standard Specification for Railway Wire-fencing and Gates.
C 14—1924 Standard Specification for Reinforced Concrete Poles.
C 15—1924 Standard Specification for Eastern Cedar Poles.
A 16—1930 Standard Specification for Steel Structures for Buildings. (second edition)
C 17—1925 Standard Requirements for A. C. Watthour Meters.
B 18—1930 Established List of Stove Bolts. (second edition)
A 19—1926 Standard Classification for Items of Highway Expenditure.
A 20—1927 Standard Specification for Movable Bridges.
C 21—1927 Standard Specification for Control Cable for Electrical Power Plant Equipment.
C 22—1930 Canadian Electrical Code, Part I. (second edition)
C22.2 No. 1—1932 Construction and Test of Power-operated Radio Devices.
A 23—1929 Standard Specification for Concrete and Reinforced Concrete. Price $1.00
G 24—1929 Standard Specification for Sampling for Check Analysis of Steel Billets, Bars and Shapes.
G 25—1929 Standard Specification for Carbon Steel Billets and Bars of Forging Quality.
*G 26—1929 Standard Specification for Commercial-quality Hot-rolled Bar Steels.
*G 27—1929 Standard Specification for Commercial Cold-finished Bar Steels and Cold-finished Shafting.
G 28—1929 Standard Specification for Carbon Steel Castings.
B 29—1929 Established List of Machine Screws.
G 30—1930 Standard Specification for Billet-steel Reinforcing Bars.
G 31—1930 Standard Specification for Rail-steel Reinforcing Bars.
G 32—1930 Standard Specification for Steel Wire for Concrete Reinforcement.

*Note: G26—1929 and G27—1929 are published in one volume.

The above are on sale at 25 cents per copy, except as noted, and may be obtained from—The Secretary, Canadian Engineering Standards Association, 79 Sussex Street, Ottawa.

APPENDIX E

LIST OF MEMBERS OF ASSOCIATE COMMITTEES

Associate Committee on Aeronautical Research

A. S. Eve, C.B.E., M.A., D.Sc., F.R.S.C., F.R.S., Chairman	Dean of the Faculty of Graduate Studies and Director, Department of Physics, McGill University, Montreal, Que.
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R. W. Boyle, B.Sc., M.Sc., Ph.D., F.R.S.C.	Director, Division of Physics and Engineering, National Research Council, Ottawa, Ont.
E. P. Fetherstonhaugh, M.C., B.Sc., M.E.I.C.	Dean, Faculty of Engineering and Architecture, University of Manitoba, Winnipeg, Man.
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John Patterson, M.A., F.R.S.C.	Director, Meteorological Service, 315 Bloor Street W., Toronto, 5, Ont.
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Group-Captain E. W. Stedman, O.B.E., M.E.I.C., A.M.I.C.E., F.R.Ae.S., A.R.C.Sc.	Chief Aeronautical Engineer, Department of National Defence, Ottawa, Ont.
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