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The Scientific Work of the Government

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Paper read before the Ninth Meeting of the National Assembly of Civil Service Commissions, by Dr. Otto Klotz.

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THE SCIENTIFIC WORK OF THE GOVERNMENT

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The Chairman then introduced Dr. Otto Klotz, Dominion Observatory, Ottawa, who, he said, had just been made a Doctor of Laws by the University of Pittsburg, this being the third university which had so honoured him.

Dr. KLOTZ read the following paper:

THE SCIENTIFIC WORK OF THE GOVERNMENT.

In order to understand the term Scientific Work it is necessary to define what Science is. One is reminded here of Lord Morley, who in one of his addresses said that there are ten thousand definitions of Religion, about as many of Poetry, and that there can hardly be fewer of Liberty, or even of Happiness.

Hence one must indeed be bold to undertake to define Science. Sir William Hamilton, the Scottish philosopher, defined Science thus: "Science is a complement of cognitions, having, in point of form, the character of logical perfection, and in point of matter, the character of real truth."

I am sure you prefer the word to the definition. Huxley it was, I think, who defined Science as organized common sense, well knowing, I presume, that common sense is one of the very rare commodities extant.

I might have done as Bernard Shaw did on an occasion when he asked the Chairman to announce that the title of the address would be given at the close of the lecture. This Shavian idea has a good deal of merit for our brief discourse to-day; it avoids the definition of the subject in advance and allows the hearers to gather from the context what the speaker understands or takes to be his subject.

Department of Agriculture.

I think we all recognize that the most important industry in Canada is that of agriculture. Canada is an agricultural country and ever will

remain so. Hence it is but natural to find that the Government—the Department of Agriculture—bestows much attention to the scientific investigation and practical development of that industry. We have here in Ottawa the Central Experimental Farm where most of the work is carried on; there are besides 18 other Experimental Farms and Stations distributed through the various provinces and under the control of the central body. I can but briefly touch on the scientific work, and the work done in a scientific manner by the many branches of this department.

In the Seed Testing Branch, analyses of seeds are made, their germinating power determined and hence their economic value to the farmer ascertained.

In the Chemical Division, the work of the laboratories engages itself with the analyses of soils as to their potash, lime, alkali or other content, their excess or deficiency in nutrients for particular crops; fertilizers also receive investigation. The results of all this valuable research is made available to the farming community throughout the land by means of bulletins widely distributed over the country.

In the Horticultural Division experiments are carried on with fruits, vegetables and ornamental plants; and new varieties are created particularly adapted for the soil and climate of certain areas.

In the Cereal Division, wonders have been accomplished by years of laborious selection in evolving or creating a wheat specially adapted for our Northwest in its early ripening qualities. The Marquis wheat which has now held the world's prize for some years was not only born here, but was literally made here on the Experimental Farm. Cross-breeding and cross-fertilization have attained great success. The ultimate value of wheat is in its milling and baking properties and qualities. These, too, are investigated scientifically here.

To effectively combat weeds a study of their life history is necessary, and experiments are made for determining the best means for their extermination, thereby adding much to the wealth of the country. In 1915, no less than 955 weeds and wild plants were identified by this branch.

Health is the desideratum with man, animal and plant. Sickness and disease, if not unavoidable, are at least controllable to a large degree. Disease in the product of our farms is a serious matter, and immediately means millions of dollars of loss in our staple industry; and its prevention and control mean likewise enormous saving or increase in our national accounts. Of recent years the most important and successful investigation that has been carried on is the one dealing with diseases of the potato —common and powdery scab. Besides the laboratory in Ottawa there is

one at St. Catharines where more particularly the fruit diseases are dealt with, the Niagara peninsula being our most important fruit area in Eastern Canada.

In the Live Stock and Poultry Divisions we may perhaps speak of the work as work done in a scientific manner rather than as scientific work. Here are tabulated feed and food and temperature and housing, all that goes to make up the debit side of the account, to offset the credit side with work, with power, with energy, with milk and butter, with meat and eggs.

Then there is the important branch of the Biological Laboratory, where diseases of animals are investigated, serums are prepared, inoculations made and active assaults directed against the outbreak of any epidemic.

We have spoken of the destructive agencies with which the farmer has to battle; among them, weeds and disease. There is yet another, insects, which is the field of the Dominion Entomologist, who with his staff and the nine entomological field laboratories in Canada is carrying on investigations upon insects affecting farm, garden and orchard crops, forests, live-stock and public health; all of which is scientific work of a thoroughly practical bearing and of immediate application.

Department of Mines.

The Geological Survey may with propriety be spoken of as one of scientific research, one elucidating the geological structure of Canada and the component parts of that structure together with the economic bearing of the constituents. Other investigations carried on by this branch of the Mines Department, and which have no very direct economic point in view, but are rather of the nature of research, in increasing our knowledge of the life of the fauna and flora of Canada, are perhaps more readily recognized as scientific work than are the surveying operations of the branch. Our flora, particularly, has been in able hands for many years, and the botanical collection of the Victoria Museum is well worth studying. The field of palaeontology has received much attention so that we are fairly familiar with the vertebrates and invertebrates that lived in these parts when Canada was submerged. Of recent years the scientific work has been increased by the opening of new fields of research: ethnology and linguistics; archeology and anthropology. These are all most fascinating studies, dealing as they do with man, his first appearance here, his evolution, his speech, his differentiation, his habits and mode of life. The story woven out of meagre material, widely

scattered, and frequently difficult of proper orientation and interpretation, is a work that every country should undertake for its own confines.

The chief function of the Mines Branch is concerned with chemical, mechanical and metallurgical investigations as are found expedient to aid the mining and metallurgical industry of Canada. This branch is of comparatively recent creation, yet its activities have greatly developed and as a result a number of well-equipped laboratories have been established where scientific investigations of a most diverse nature are carried on. Besides the chemical laboratories, there is a fuel testing station and laboratories; an ore dressing and metallurgical laboratory; a ceramic laboratory for the study of our clays; a structural materials testing laboratory and a metallographic laboratory.

The enumeration of these laboratories alone will give some idea of the wide range of scientific work carried on by this branch. And be it observed that its services are at the disposal of the public at fixed and moderate fees, so that analyses of ores and metals, and salts, and waters may be obtained at reasonable figures, before embarking in some commercial enterprise relative thereto. It is scarcely necessary to add that the heads of all the laboratories are trained university men, in fact this applies to all the branches of the various departments where scientific work is carried on.

Department of the Naval Service.

The practical value of the Tidal Surveys is so obvious that it need but be mentioned. From the scientific point of view the most valuable data supplied by the Tidal Survey are the bench-marks of mean sea level on the Atlantic and Pacific coasts, as well as on the St. Lawrence. These furnish the datum planes to which all surveys for levels are referred. Years of observation are necessary for acquiring the necessary data and skilful interpretation in deducing final values.

Among the highly scientific work carried on by the Government is that of the Marine Biological Stations at St. Andrews, N.B., and Departure Bay, B.C., where a series of elaborate fishery and technical researches are carried out. Of the questions studied may be mentioned: the life history of the Atlantic food fishes; investigation of the fatal epidemic of disease among the herring; the parasitology of fishes; studies in the tissues of dog-fish and sharks; the spawning and life history of the halibut; the extent of the kelp resources of our Pacific coast and other similar problems. The work is carried out under the auspices of the Government by scientists and biologists from our universities during their

summer vacations. The solution of the problems undertaken means a great increase in the wealth of our available sea-products, an increase to our revenue, and an increase to our food supply as well as to an available surplus for export. This scientific work has an eminently practical and economic bearing.

The Meteorological service is attached to this department and what "Old Probs" gives and does to us, you know. He played us rather a mean trick a fortnight ago, the day he got his knighthood—it was the King's birthday—he gave us rain. Science perhaps required it, but we shall not soon forget it.

Department of Inland Revenue.

In this department the principal scientific work which is carried on is that of the Chemical Laboratory in connection with the Adulteration of Food, the chief laboratory being in Ottawa, with branches at Halifax, Winnipeg and Vancouver. This is the line of work in which Dr. Wiley of Washington rendered such invaluable services to his country while he was the head of the department that dealt with foods, patent medicines and even with Bourbon and Scotch whiskies. The scientific work carried out by the Inland Revenue Department has mitigated to a large degree the imposition upon the public of adulterated foods, or foods of inferior quality, or of foods different from what their labels indicate.

Over 5,000 analyses have been made in a single year, and each one meant a public benefit and enforced statutory morality on the part of the producer.

Department of the Interior.

Forestry.—In the laboratories of this branch investigations are carried on into the strength of Canadian timber, the suitability of different woods for pulp and all questions which have a bearing on making Canada one of the great manufacturing nations in forest products.

Irrigation and Water-power.—The questions pertaining to irrigation and water-power receive scientific attention, as is eminently proper in national good housekeeping.

Dominion Land Surveys.—From a scientific point of view, probably the greatest contribution that has been made by this branch is the introduction and development of the method of photographic surveying. Its superior merit for a mountainous country was amply demonstrated by its use for the delineation of Southeastern Alaska in connection with the Boundary Survey.

The Observatory.—Possibly in the popular mind no branch of the government service fills so adequately the idea of scientific work as does that of the Observatory, with a lingering feeling that it is not very closely connected with this mundane sphere. This latter idea is not quite correct, and you are more frequently making use of the astronomer's midnight vigils than you may be aware.

The Dominion Observatory was the outgrowth of the terms upon which British Columbia entered the Dominion of Canada. She gave lands 20 miles on each side of a railway to be built by Canada to and through the province. That railway belt, in order to be correlated to the Dominion Lands system of the Northwest, required to be astronomically fixed upon the earth.

Thereby began the practical astronomic work of the Government in the accurate determination of latitude and longitude. That was in 1885. The work has been extended across the continent. Ottawa has been made the chief reference point for Canada, and the Observatory has been built, which now engages in other work too, work of research, besides the practical work that called the Observatory into being.

The work of the Observatory may be divided broadly into: Astrophysics, Time and Meridian work, and Geophysics.

With the ancient Greeks, Hermes, or, as later known by the Romans, Mercury, was the messenger from heaven; to-day, that messenger is Light, more fleet-footed than Hermes or Atalanta, for in the twinkling of an eye he could skip from the moon to us. This messenger, this ray of light, this motion of the immaterial, comes to us laden with a story, with a wonderful story from the home he left some time ago, perhaps ten or a hundred or five hundred years ago, travelling all the time at 186,000 miles a second. Only a rigorous cross-examination, however, can elicit any information, and with much difficulty are answers obtained. The principal questioners are the prism and photographic plate on which his handwriting is impressed, which tell us the constituent parts of his home, what gases and elements surround it, and whether the home—the star—is approaching or receding from us. To such analyses the ray of light is put at our observatory. It may be mentioned too that the photographic plate can obtain the record of stars so faint that no human eye will ever see them, be the telescope ever so large, for the telescope is but a large eye. All researches reveal more and more that all bodies in the universe are of one great family, ultimately with the same finger-print.

In another branch stars are put to a different use. It is well said that "order is the first law of heaven"—would it were so on this earth. You

look at your watches a score of times a day, probably never thinking where your time comes from. It comes from some astronomer, perhaps ours, who has spent the night observing and recording the motion of the stars. And this same motion enables us to delineate on the earth our geography. Thus Canada is being put in its accurate position on this globe, and takes its place in the sun. You travel by sea o'er this wide world with utmost confidence in the captain of the ship, but you will find in his cabin the nautical almanac giving the position of the heavenly bodies for his guidance. In such fundamental work our Observatory is engaged. It is not spectacular work, but steady, conscientious, exhausting and exhaustive work for the benefit of man.

The nursery rhyme, "Twinkle, twinkle, little star, how I wonder what you are," occurs also to the astronomer. But he trains his spectroscope on the little spot of light and behold—twins are revealed, hugging too closely, however, to be seen as such by the eye. The astronomer watches them for hours, for days, as they write on the photographic plate, then determines what their relative masses are and how long it takes them to dance once around their common may-pole. Such work, too, the Observatory does. There are other twins, and even triplets, that take a somewhat wider range of motion, and which can be directly seen and put to observational scrutiny. They too fall within our purview.

Next let us put our feet on terra firma—terra firma when it isn't shaken by earthquakes. Let me assure you that earthquakes are very interesting scientific phenomena on this earth—of course we would all like to bar personal experience. However, by means of our modern highly sensitive earthquake instruments, facts and truths of the interior of the earth have been revealed that heretofore were debatable questions. Our earth is solid and has no liquid interior. The seismograph at the Observatory records every decent earthquake, whether on land or in the sea, whether in Asia, the East Indies, South America or in the Aleutian islands. Like the ray of light, the seismic ray writes its message, its hieroglyphs, in bold lines on the photographic sheet. It, too, has written its story; whence it came, how far away was its hearth, how deep down into the earth it dipped to find its easiest and swiftest path. The hieroglyphs have not all as yet been read, the Rosetta stone has not yet been found, but a good deal has been deciphered. If there has been a good shake in Turkestan, say, we can tell within fifty miles how far away it was from Ottawa, sometimes even less, and how long it took to reach us—hence also the elasticity of the material through which it passed. From the study of earthquakes we are learning of the vulnerable parts of this earth, for there the earthquakes

always take place. It is a study in which man is vitally interested, and the prediction of earthquakes is not entirely a dream, it comes within the range of scientific investigation. Another branch of geophysics that the Observatory pursues is that of gravity, upon which is dependent the shape and form of the earth. This work rests on the observation of the swing of a pendulum—no clock-work. The number of oscillations a pendulum makes in an hour or a day, depends on the pull that actuates it—not political pull for that is too uncertain. The farther we are from the centre of the earth the less the pull or force. If a pendulum clock keeping accurate time in Ottawa were taken to Washington it would lose time, because Washington is farther from the centre of the earth than we are and besides is more apt to fly off the handle than Ottawa, i.e. the centrifugal force is greater there and decreases the gravitational effect. You don't weigh as much in Washington as you do here for the same reason,—weighed on a spring balance. The pendulum not only reveals to us the shape of the earth, what its flattening is, but also anomalies in structure underneath us, whether there are vast masses of greater or less density than the average below the surface. From the pendulum we have learned that the Rocky mountains float so to speak in the crust of the earth like an iceberg does in the sea. This means that the roots of the mountains are composed of matter less dense than at the same depth say under the sea. The crust of the earth does not support the Rocky mountains or any other range; they are in equilibrium. In this investigation of the earth, which is an international undertaking, the Observatory is taking its part. Let me give you just one figure in regard to the refinement of pendulum observations; a single swing of the pendulum is determined with an accuracy of the units of the 7th place of the decimal, that is, to the ten millionth of a second of time.

The third branch of geophysics pursued by the Observatory is that of terrestrial magnetism, a subject of concern to man on land and sea, particularly the latter. When the poet exclaims "True as the needle to the pole" we must make allowance for poetic license, otherwise the captain of a ship steering by compass would never reach his destination. The needle doesn't point to the pole except along a line where its deviation to the west meets or merges into deviation to the east. The needle is almost as fickle as the weather. Our first work is to ascertain its general behavior in the wide extent of Canada from the Atlantic to the Pacific, then to study its daily and annual idiosyncrasies with some odd ones thrown in. These last have been traced pretty well to the sun as the disturbing element but just how, we do not know as yet. There is scarcely any investigation

that we make on this earth that does not ultimately lead us back to the sun. We ourselves are vitalized sun-beams, and hence our temperament should be more or less sunny. The sun-worship of the old Aztecs had some sense. Terrestrial magnetism, the northern lights or aurora borealis, disturbances on our telegraph lines, and sun-spots have an interrelationship well worthy of study, research and investigation.

The Geodetic Survey.—There is one more branch that properly comes under scientific work, and that is the Geodetic Survey of Canada, for in the network that is being thrown over the country for subsidiary and detailed survey to connect with, the ultimate degree of refinement of measurement is applied, and, thereafter, the crucial application of mathematics to fit the survey to the actual surface of the earth, involving computations of the most intricate nature, is essential that the results may stand for all time and inure to the everlasting benefit of the people.

In closing this necessarily brief review of the scientific work carried on by the Government, every scientist is fully aware that a Government, which is but a reflex of the people, looks upon scientific work with an eye to its material value. "What is it worth?" it asks. "What benefit is it to the people that pay for it?" This is quite a natural attitude. But it must not be carried too far. No scientific truth discovered is useless; sooner or later it will find its place and application to some useful purpose for the benefit of man.

Let us not forget that nearly all our comforts and amenities of life owe their origin to discoveries of science, which were not made to find means to provide those comforts and amenities, but to delve into the untold mysteries and fundamentals of nature. Wisely directed scientific research pays, even in this materialistic age.

The scientific work carried on by the Government of Canada is creditable. There is a large field to cultivate, and the people have a right to ask that it will be well tilled, and that the harvest may be commensurate with the labour and cost.