

Royal
Meteorological
Society

THE CANADIAN BRANCH - R.M.S.

by
F. W. Benum

THE AERIAL ENVIRONMENT

of the
FOREST

by
H. Cameron

CANADIAN
BRANCH

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by

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and

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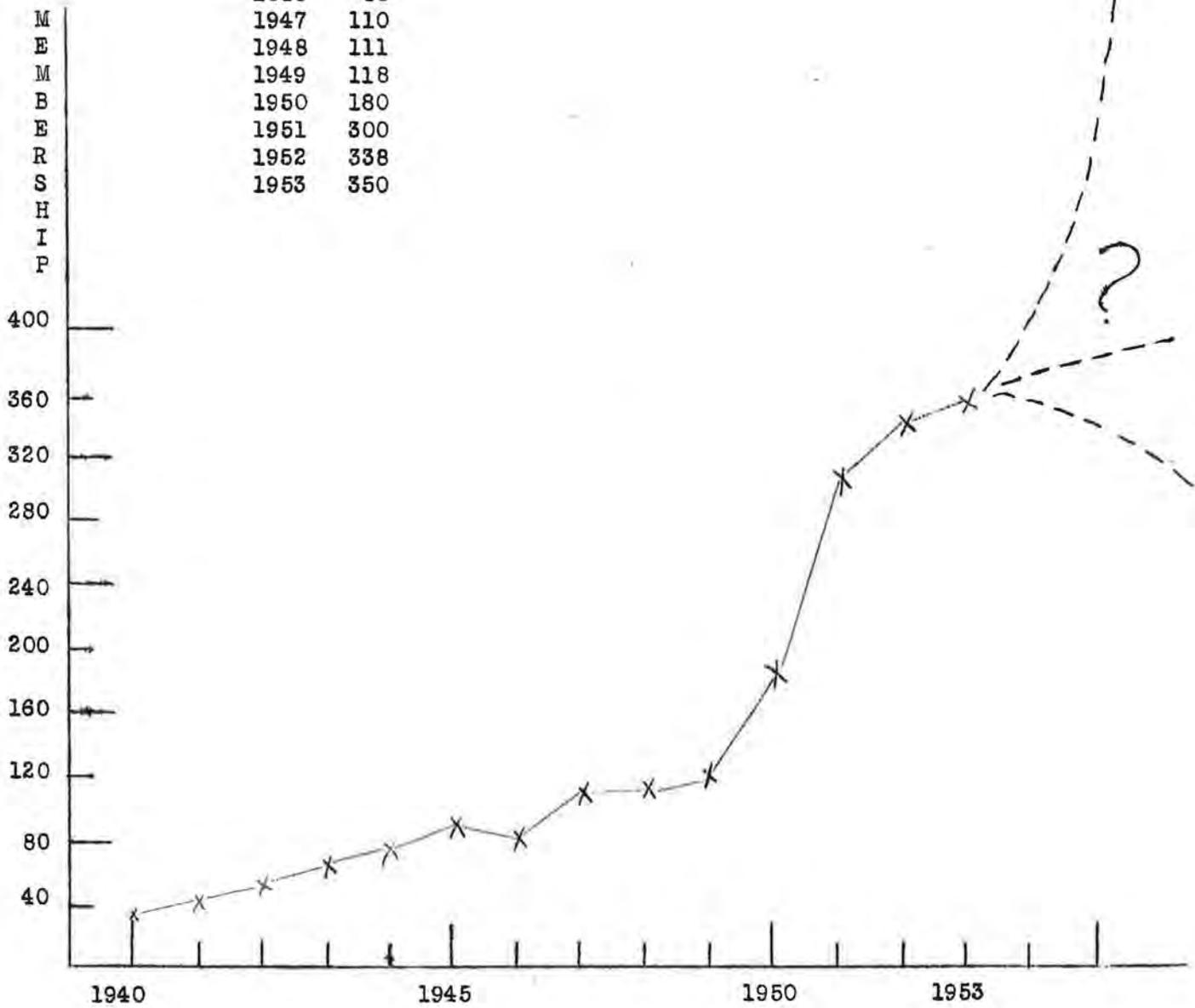
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the Royal Meteorological Society, Canadian
Branch, Toronto, Thursday, January 29, 1953.

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THE GROWTH OF THE CANADIAN BRANCH

THE CANADIAN BRANCH—RMS

F.W. Benum

It has now become traditional for the President to address the annual meeting of the Canadian Branch on a subject of his own choosing. I have selected as my topic for this evening the Canadian Branch of the Royal Meteorological Society.

My term of office as President ends today and since this marks the end of just over four years as one of the officers of the Branch, it seems fitting that I should say something about the work that has been done during the past four years and about the task that lies ahead.

I feel very honored that my name is being recommended to the Executive Council for the office of Vice-President for Canada. If I am found acceptable, I shall be very glad to take over when Mr. Thomson, our present Vice-President for Canada, retires from office on September 30th.

I have been a member of the Royal Meteorological Society for several years. Before moving to Toronto, however, I did not take a particularly active part in the affairs of the Branch. I was Councillor-at-Large once or twice, but I must admit I contributed very little. Shortly after I came to Toronto in 1948, Mr. R.C. Graham, who held the office of Secretary, moved to Goose, Labrador. The Executive Committee selected me to fill this vacancy for the remainder of 1948. I gladly accepted this offer. In 1949 and 1950 I was elected Secretary and in 1951 and 1952 the Canadian Branch did me the high honour of picking me for the role of President.

RETROSPECT AND PROSPECT

During this period, there have been substantial changes in the Canadian Branch. Looking back over the past four years, I realize how much has been done. I also realize how much more has been left undone. During this period the membership increased three-fold. The problems of running the Canadian Branch have increased correspondingly. Many of these problems are still unsolved. I realize, therefore, that I am passing on to my successor a tough job. We have passed through a very important phase in the history of the Canadian Branch. We are approaching a more important phase. I think this is evident from the graph showing the total membership of the Canadian Branch.

Following the first Joint Royal Meteorological Society-American Meteorological Society meeting held in Toronto in 1939, the Canadian Branch was formed. The membership at the beginning was 34—14 Fellows and 20 Associates. The membership increased slowly but steadily from January 1940 to January 1945. At the end of the war there was a slight drop but then it resumed the climb again in 1946 and remained level through 1947. During 1948 there was another slight increase. Suddenly in 1949 there was a very marked increase followed by a much larger one in 1950. Then the rate of growth started to fall off in 1951 and slowed down very appreciably in 1952. The question now is, where are we going from here?

Before we can attempt to forecast the future of the Canadian Branch, there are four other questions which must be answered:

1. Is a meteorological society needed in Canada?
2. Is the Canadian Branch a scientific society?
3. What is the object of the Canadian Branch?
4. How can we achieve this object?

I shall try to give you my answers to the first three questions and then present a few suggestions in regard to question 4, but I will not try to answer the question regarding where we are going. The real answer to that question can only be found in the future. I firmly believe, however, that if the Canadian Branch wants to continue to grow into a large, healthy and strong meteorological society, there is nothing to stop it.

THE NEED FOR A METEOROLOGICAL SOCIETY

In answering the first three questions, I will first say a few words about our Canada. As you have probably read in the newspapers and heard on the radio, a number of persons in high office are trying to forecast the future population of Canada. These estimates vary anywhere from 20 million people by 1975 to 50 million by the year 2000. Although we may not be qualified to judge the reliability of any of these estimates, I think that it is fairly certain that the population of Canada will increase very substantially during the next 50 years. This means that, although the resources of Canada are tremendous, we cannot afford to squander them. To take care of the expanding population, we will require an expanding economy and increased efficiency in all our activities to ensure that the standard of living in Canada is not only maintained but raised to the highest possible level. The expanding economy requires full use of our resources and efficient production to meet world competition.

Weather plays a role in almost every human activity in Canada. This means that a weather service is a necessity for numerous activities of great economic importance. In the past a weather forecast may have been considered as a luxury, but it is now fast becoming a necessity, particularly in a country such as ours. Regardless of whether Canada is at peace or at war, there is a tremendous need for weather services.

Canada is growing very rapidly internally and externally. She is rapidly reaching maturity and is achieving a sense of confidence in national and international affairs. Therefore, in addition to serving the community of Canada, the meteorologist should use his favoured position of being able to serve the international community through his work which tends to international collaboration and international bonds.

In this Canada of ours both the Meteorological Division and the Canadian Branch have important roles to play.

The Meteorological Division, as the state meteorological service, plays a tremendous role. It is responsible for the taking of observations, for issuing weather forecasts, and for the many facets of providing weather service. It has recently increased its activities in research and, through its technical circulars, is undertaking the publication of large numbers of papers. It is responsible for the training of meteorologists in Canada and undertakes to collaborate with the World Meteorological Organization and other international

organizations of this kind. The scope of the activities of the Meteorological Division is so large that one might think that there is very little left for the Canadian Branch. However, the Canadian Branch has a very real role to play, but before I can fully answer this first question, I must go on to deal with the second: Is the Canadian Branch a scientific society?

The object of the Branch as stated in the By-Laws is as follows:

"The Canadian Branch of the Royal Meteorological Society was established for the advancement of meteorological science in Canada and Newfoundland". The last two words indicate the obsolescence of the By-Laws. However, I do not think that the object of the Canadian Branch has changed in any way since the Branch was first formed. The Executive Committees on which I have worked have adhered to the best of their abilities to the object as laid down in the By-Laws. The criticisms that the Executive Committees of the Canadian Branch have tended towards a pseudo-scientific type of organization are unjustified.

In support of the actions taken by the Executive Committees of the past four years, and as a guide for the future, I would like to quote from outstanding members of the Parent Society and others who have expressed what I want to say much better than I can. In his Presidential Address, delivered before the Royal Meteorological Society on January 25, 1950, Sir Robert Watson-Watt stated:

"Thus late I reach the question which has not, so far as I can judge, been posed in any Presidential Address in the last thirty years. What is the state of our science and our art; what are we doing to ensure their healthy progress? This Society has, I believe, a peculiarity not special in kind to itself, but special in relative importance. Meteorology is the science of the atmosphere; science is, according to the dictionary, ordered knowledge .

"Now ordered knowledge about the atmosphere is of profound interest, not only to the people who want to pursue the knowledge in an austere scientific way, those who pursue it as an exceptionally difficult form of physics conditioned by the vagaries of water in the atmosphere, but also to those who are interested in meteorological phenomena as elements in nature study, to those to whom the application of the science of meteorology is of economic value, to those to whom the applications of meteorology form a substantial part of that uninterrupted progress of civilization which goes on in these doubtful years of 1949-50, and to those to whom every meteorological state is a picture. One of the troublesome things about meteorology is that it is profoundly interesting to everybody who has to live on this planet of ours and that for a great variety of intellectual, practical and aesthetic reasons".

And he goes on further to say: "Who are the Fellows of this Society? They are without exception amateurs and dilettante, in the original and genuine sense of these words. I believe that there is nobody who devotes his attention, professionally or otherwise, to meteorology, who is moved by any other primary impulse than that he loves the subject; the meteorologist, the Fellow of this society, is certainly a lover, and one who takes delight in his subject. Amongst these amateurs are many classes, those whom I may with deep respect call the academic professionals, those who are the official professionals, in the Meteorological Office in particular, those who are the students, the most

important of all the members of the meteorological community--all lovers of the subject, and all exercising their profession only because they love their subject. There are the consumers of meteorological information, the public utility officers and the like, and there are those to whom we too readily confine the title of amateur in its most recent sense".

I could go on and take further quotations from this excellent Presidential Address. However, I would like to quote other authorities on this point. In an editorial written for the most recent issue of the Quarterly Journal, Sir David Brunt said: "However interesting meteorology may be as an academic study, it has still wider implications. In my view, meteorology should be regarded as one aspect of a wide human culture, having points of contact with almost every variety of human activity". And in a paper presented at the Centenary Celebrations of the Parent Society, Sir David wrote: "Meteorology is regarded by some as a pure academic study, by others as merely a means of forecasting tomorrow's weather. I would put forward a wider view, that meteorology is a part of human culture, which has applications in almost all aspects of life and work".

In the foreword to the first issue of "Weather" magazine, Gordon Manley, then President, said: "Sciences like meteorology are growths which flower increasingly in successive generations; and while such a science receives additional cultivation by those who embark on a professional career, it may also seed itself and flourish independently in those whose livelihood may be far removed from the pursuit of knowledge. From its foundation, this Society has existed to bring together all who are interested in meteorology in furtherance of the object expressed in its Charter 'the advancement of meteorological science'. Accordingly, among its members are found not only the majority of professional meteorologists, but, in addition, a large number of those who make a study of the weather their hobby, or who maintain an interest on account of the extent to which it overlaps their own activities. Such men include, among others, farmers, engineers, actuaries, railwaymen, doctors, those responsible for public utilities, road transport operators, as well as seamen ..."

Mr. N.R. Hagen, Meteorological Attache of the United States, speaking for Commander Reichelderfer at the Centenary of the Royal Meteorological Society, stated: "Communities gradually, but far too slowly, are becoming aware of the valuable public services that can be performed by a modern and well-organized meteorological organization. Methods whereby this community-educational process could be speeded up merit further attention and call for the combined efforts of Meteorological Directors, meteorological societies, and meteorologists generally".

It would be possible to go on at length quoting similar statements made by meteorologists of world renown who do not feel that it is unscientific to bring together the amateur, "in its most recent sense", and the academic professional. I think that you will agree with me that, from these quotations, those of us, who feel that the Canadian Branch has an important job in bringing meteorology to all our fellow Canadians who are interested in meteorology, do not stand alone. Before leaving this point, I would like to quote from a circular letter sent out to members of the Society in Canada about January 1940 by the Chairman of the Arrangements Committee, Mr. Andrew Thomson. In this letter Mr. Thomson said: "The number of members (in Canada) is quite small at

present and all those connected with the Royal Meteorological Society should endeavour to secure the membership not only of professional meteorologists but also of interested laymen. More than half the membership of the Society are not professional meteorologists".

I conclude, therefore, that the present Canadian Branch is a scientific society in the best traditions of the Royal Meteorological Society and in accordance with the far-reaching thoughts of those charter members who first launched the Canadian Branch. Admittedly, we have a long ways to go to achieve the maturity and stature of the Parent Society, but nevertheless we are a scientific organization. I also believe that there is no contradiction in terms in saying we can be a popular scientific society. We have to be popular and well known in order to carry out our full role in Canada. I will now try to answer questions 1 and 3 by giving you my views on the role of the Canadian Branch.

ROLE OF THE RMS

I feel that the primary role of the Canadian Branch is to carry out the object of "the advancement of meteorological science in Canada". It is true that we share this purpose with the Meteorological Division. But it must be appreciated that the Meteorological Division is primarily established for the purpose of providing weather service. In connection with this responsibility, it has to assume a large portion of the responsibility for the advancement of meteorological science. However, it cannot possibly cover all the facets involved in such a broad purpose. It is the responsibility of the Canadian Branch to handle those phases which can only be partly handled or not handled at all by a state meteorological service. Some of these facets are:

1. The encouragement of meteorological research. This is self-evident. The Society should make every effort to encourage meteorological research in Canada and to make provision for the discussion and publication of original work.

2. The distribution of meteorological knowledge. I will elaborate on this later.

3. To serve as a meeting place for all interested in meteorology. Although most of the meetings of the Canadian Branch have been held in Toronto, I feel that the Canadian Branch has the responsibility of establishing groups wherever they can be formed in communities scattered across Canada. During the past four years there have been a few meetings at other points such as Vancouver, Edmonton, Winnipeg and Montreal. I think that the Canadian Branch has a very real responsibility in establishing groups and arranging for meetings in any community where there is a sizeable number of people interested in weather. The Canadian Branch should be the organization to which anyone interested in weather can belong, where he can go and discuss his meteorological problems with others who have similar problems and with the professional meteorologist who can help him. The Canadian Branch should encourage meetings with particular consumer groups to determine their particular meteorological requirements. This is done to some extent by the Meteorological Division by contacting the particular user organizations. How much better it would be if every person interested in meteorology could have an opportunity to learn more about meteorology at meetings with his fellow members in a Society where he has a sense of belonging and to which he

can give his support, financially and otherwise. This is a facet of the advancement of meteorological science that has been largely neglected and it is something that the state meteorological service cannot properly undertake. It fits in very well, however, with the proper role of a meteorological society.

4. The development of a strictly Canadian meteorological publication. We now have three publications. The Quarterly Journal is one of the outstanding publications of its kind. "Weather" magazine is excellent. Although these two publications are printed in England, as members of the Royal Meteorological Society, we should regard them as our own and as the media for disseminating papers, articles, notes and correspondence produced by members of the Branch. There is still a need for a strictly Canadian publication dealing with Canadian problems from a Canadian point of view. In 1950 we dressed up the Canadian Branch publication with this in mind. It has been well received in Canada and even outside of Canada. But it still does not have a name and could stand considerable improvement and modification. It should be expanded to cover all the activities of the Branch and it should be developed to cover the activities and work of many of our members who are now making very specialized applications of meteorology. This publication should be directed at the interested layman and should be written in simple and plain language. Original scientific communications and articles of a longer and more technical character should, if acceptable to the editors, be published in the Quarterly Journal. Articles, notes, etc., of international interest should be published in "Weather". Papers and articles not suitable for these publications but still important enough to justify distribution to the professional meteorologists will normally be published by the Meteorological Division. There is still a large field for a Canadian Branch publication in satisfying the meteorological needs of the interested layman in Canada. In suggesting this, I want to make it quite clear that I am not proposing that we develop a publication in competition with our other publications. The Canadian Branch publication should not include material which would normally be printed in the Quarterly Journal or in "Weather". If a paper is Quarterly Journal material, it should be forwarded to the editors of the Quarterly Journal. Similarly, if it is suitable for "Weather", it should be submitted to the editors of "Weather". This is the present policy and this has the full support of the Parent Society. I am not suggesting a change in this policy. In addition, the Canadian Branch publication should not be used to publish papers which are not acceptable to the editors of Quarterly Journal and Weather, unless they are turned down because the topic is of local interest only, and then only after the papers have been thoroughly screened by the editors. The policy of the editors of the Canadian Branch publication should be to give special attention to papers dealing with problems of applied meteorology in Canada, without any long and abstruse mathematical equations, and to complete reports on the activities of the Canadian Branch and the technical activities of meteorologists in Canada.

5. The Canadian Branch should undertake to encourage trained people to come into meteorology. I do not think that, although there is a need for it, the Canadian Branch should concern itself directly with the economic conditions of professional meteorologists. This can best be handled by organizations established primarily for this purpose. However, it should concern itself very much with disseminating information on meteorology with a view to stimulating a wide interest in it and thereby stimulating a flow of highly qualified people, particularly the young, into the field of meteorological work.

6. The meteorological society should act as the conscience of the state meteorological service. In Canada we have a single-service system and as a result almost all professional meteorologists in Canada are employed by the state meteorological service. Hence, a strong meteorological society representing not only the professional meteorologist, but also a broad cross-section of interested laymen, can be of considerable assistance to the Meteorological Division. As Sir Robert has said: "The price of a good state service anywhere is eternal vigilance; and the major share of that constructive vigilance and its expression should come from outside the state service but from inside the assembly of the amateurs".

7. The development of a code of ethics for professional meteorologists in Canada. The American Meteorological Society has prepared such a code of ethics in the U.S.A. I feel that it is the responsibility of the Canadian Branch to develop a similar code of ethics for Canadian meteorologists.

8. The Canadian Branch has a very important role to play in international meteorology. Thus far very little has been said at Canadian Branch meetings about the WMO and other international meteorological organizations. However, we must remember that the international meteorological organizations were pioneers in international co-operation. The Canadian Branch, therefore, has a very large role to play on behalf of Canada in international meteorology. This year we are very fortunate that there will be a Joint Meeting of the Royal Meteorological Society and the American Meteorological Society in Toronto. When the first and only joint meeting of this kind was previously held in Toronto, the Canadian Branch was conceived. I look forward with a great deal of expectancy towards this year's joint meetings. I believe it will mark the beginning of the next important phase in the history of the Canadian Branch and I hope it will mark the beginning of increased participation by the Canadian Branch in international meteorology.

I think that, from what I have said, you will agree that the Canadian Branch is needed in Canada, has some very real objectives to aim at and in accomplishing these objectives will not in any way run the risk of deteriorating into a pseudo-scientific organization. In fact, in striving to accomplish its purpose, I believe that the Canadian Branch has grown and will continue to grow in stature so that all members, professional and non-professional, should be proud of it.

MEANS TO AN END

Now having established the fact that the Canadian Branch has a part to play in Canada, how are we going to accomplish it? I have a few suggestions which I would like to pass on to the new executive and to all members of the Society for their consideration.

As I pointed out, we seem to be reaching a plateau on the membership curve and I feel that this may be attributed to several reasons. First, there is the problem of handling an increasing membership with the small number on the Executive Committee and the limited facilities at the disposal of the Executive. Secondly, at the Annual Meeting last year, the Executive was instructed to tighten up on the qualifications of eligibility

for membership in the Royal Meteorological Society. Third, entrance fees are now required from all applicants for membership in the Society. Fourth, the decrease in the rate of growth this year was to some extent planned, as the Annual Meeting last year felt that we should take a breather while we determine the wisdom of an intensive membership campaign amongst non-professionals. Although I do not personally agree with some of these restrictions, the outgoing Executive Committee has followed them to the letter throughout the past year.

I could mention a number of other reasons for the lessened success in our membership drive during 1952. However, I think that the above are the most important ones. As the membership is one tangible indication of how well we are playing our proper role in Canada, I think we should look again at the membership graph. The future membership curve may travel in any one of three directions; down, remain almost horizontal, or go up.

If we relax our efforts, the curve will certainly go down and the Canadian Branch could slowly waste away. If we restrict membership to professionals, the Branch will remain almost as is, its rate of growth being tied to the rate of increase in the number of professional meteorologists in Canada. The third alternative is to renew our efforts to further the real object of the Society. I think that this would mean a tremendous growth of the Canadian Branch. However, as I have said earlier, I am not going to try to forecast which path we will follow. The following are a few suggestions which I feel, if adopted, would assist the Canadian Branch considerably in carrying out its object as a scientific meteorological society in Canada.

1. First, priority must be given to the revision of the By-Laws. These must be streamlined and brought up to date. Before much can be done on revising the By-Laws, there are several points which must be clarified. The object of the Canadian Branch is well known, but it must be spelled out in greater detail. How the object is to be achieved must be decided upon and have the whole-hearted support of all members.

2. We need to reorganize. The Executive Committee is almost too small to handle the present business of the Branch and certainly would be swamped if the Branch grew much larger. In addition, the organization should be changed so that provision is made for the formation of local branches or groups across Canada and for representation on the Executive Committee of all classes of members. The Meteorologists BA should have a large representation, the R.C.A.F. personnel should have a representative, and the smaller groups should have a separate or joint representation.

3. We should encourage and sponsor meetings of local groups across Canada by providing financial and other aid.

4. We should strive for the expansion and improvement of the Canadian Branch publication. Select a name for it, arrange to have it printed, dress it up with a proper cover and encourage members to write the type of article required for this publication.

5. We should review the two classes of membership. Personally, I feel very strongly that there should continue to be two classes of membership. However, I do think it is wrong that the only difference between the two is the amount of the annual fee. I strongly favour two classes of members, one for the professional, the other for the non-professional, each class having its own rights and privileges, each receiving publications as decided for the class and with annual fees set accordingly. The two classes can still be designated as Fellow and Associate, although I do not care much for the name Associate. I would prefer names such as fellow and member, or professional member and member.

6. Renew our membership campaign amongst non-professionals as well as professionals. To ensure a large number of applicants, I think we have to introduce new membership classes, produce an improved Canadian Branch publication, arrange for meetings, etc. While the spade work is being done to accomplish these things, we should renew our campaign for members in the Universities, in industries and wherever the interested layman may be found, as well as continuing the membership campaign amongst the professional group.

7. We should strive for more publicity--in the newspapers, periodicals, and elsewhere. I think that these media should be exploited since there are many weather enthusiasts who are not aware of the Society's existence.

8. In order to carry out its purpose, the Canadian Branch will need funds. To launch a printed publication, to arrange for meetings across Canada, etc., will cost money. It is possible that grants-in-aid might be forthcoming from some source to help us get started. However, we should not rely on this alone. I do not think it is desirable or necessary for a scientific society to rely on charity alone in order to build up a strong enough organization to carry out primary objectives. We should aim at getting this money from our own pockets, from increased membership and from full utilization of our resources and abilities.

9. We should be prepared to discuss this whole problem with the RMS delegates attending the Joint RMS-AMS Meetings in Toronto next September. The Parent Society has always been most sympathetic and most helpful in solving our problems. Sometimes, I feel that the patience of the Executive Council must have been sorely tried during the past four years by its rambunctious infant in Canada. However, they have always given us their full and generous support in whatever we have tried to do. I feel sure that the delegates from U.K. will be very glad to discuss any plans the Canadian Branch may have, help us to work them out and give freely of their long and broad experience in matters of this kind. Since the Nominating Committee very wisely elected as Councillors-at-Large for 1953, members who might be expected to be in Toronto during the Joint Meetings next September, the Executive Committee will be in a position to present to the RMS delegates from U.K. a national cross-section of its views on operating the Branch in Canada. I strongly urge the Executive to have a draft of the revised By-Laws ready for discussion with Council members when they are in Toronto next September.

10. Last, but not least, I would like to mention the work involved. To build a strong society involves a great deal of work. During the past four years the Executive Committee members have done a great deal of work. They have had the generous support of a large number of other members of the Society who were not on the Executive. Most of these were members in Toronto,

but by no means all of them. There has been some reluctance on the part of some members, however, and this reluctance was not owing solely to the work involved, but rather to disagreement with the policies of the Executive. To these members, I would like to say that no Executive Committee, however well qualified, enthusiastic and hard-working, can alone think of all the right answers to all of the problems all the time. I would also like to add that this is your society and every member has an equal say in how it should be run. If you don't like the way it is run, you don't have to lump it. All you have to do is get in there and pitch. I am sure that the new Executive Committee will be most appreciative of all assistance given in helping to work out the many problems involved in running the Branch.

ENVOI

Although my term of office ends tonight, I would like to take this opportunity to make a request of all members of the Branch. First, I would like to see individual comment from all members across Canada on the suggestions I have made this evening. Secondly, I would urge all members to give full support to your Executive Committee this year. There will be much work to be done in connection with the Joint Meetings, and there will be a great deal more work if the Canadian Branch is to reorganize and to gird itself for the big expansion, which I think we would all like to see. Third, if you don't like something, do something about it. But don't let it consist merely of criticism or unwillingness to act on Committees. If you don't like the way the Executive Committee is handling some problems, draft a better plan and submit it to the Secretary. I am sure that the new Executive Committee will welcome any constructive ideas and assistance you can provide. It will not run out of problems.

REFERENCES

- | | |
|------------------------|--|
| Sir Robert Watson-Watt | 1950 Quart. J. R.Met.Soc., London 76,
p.115. |
| Sir David Brunt | 1952 Quart. J. R.Met.Soc., London 78,
p.485. |
| " | 1950 Quart. J. R.Met.Soc., London,
Centenary Proceedings p.235. |
| Gordon Manley | 1946 Weather, London 1, p.1. |
| N.R. Hagen | 1950 Quart. J. R.Met.Soc., London,
Centenary Proceedings p.244. |
| A. Thomson | 1940 Circular Letter to all R.Met.Soc.
members in Canada. |

THE AERIAL ENVIRONMENT OF THE FOREST

Hugh Cameron

INTRODUCTION

An organism without environment is inconceivable. Living things have certain requirements that must be satisfied by their surroundings if their life is to continue. Their physiological processes, which, to sustain life, must all continue at rates above definite minima, are largely controlled by environmental conditions or substances.

Environment in its entirety includes everything that may affect an organism. Any force, substance or condition which affects organisms in any way becomes a factor of their environment. The sum of all such factors constitutes environment. These factors may be grouped into three major categories: climatic or aerial, physiographic, and biologic. Although they may be studied or measured individually, they must always be considered in terms of their interacting effects upon organisms and each other. The resulting complexity of this environment suggests the necessity of drawing upon the knowledge of many fields of science for its understanding.

One field of science dealing in part with the climatic or aerial portion of plant environment is climatology. It is closely related to meteorology and geography, since the variable elements of the atmosphere are strongly influenced by the quasi-invariant physical factors of our earth. That part of climatology most applicable to the thin layer of the atmosphere inhabited by forest is known as micro-climatology--climate on the smallest scale.

Micro-climatology is, therefore, a subdivision of climatology, and has come to occupy a special position in the realm of natural science. It is closely connected with many kindred sciences through which its advancement is being furthered by the research of entomologists, ecologists, botanists, foresters, agriculturists, and others. Micro-climatology affords an exceptionally fine example of a community scientific effort.

MICRO-CLIMATIC ELEMENTS CONTROLLING THE FOREST'S AERIAL ENVIRONMENT

It is not possible to enumerate all controlling elements, but solar radiation, temperature, wind, and humidity are those which exert the greatest effect on the forest's aerial environment and they will be discussed individually.

The Solar Radiation Element

In the forest solar radiation is intercepted by leaves, needles, twigs, and branches, so that only a small percentage reaches the forest floor. Throughout the forest, the crown surface becomes the outer active surface, with only mature trees of the tallest species ever receiving full insolation. At lower levels, small shrubs, or undergrowth in general, receive only subdued illumination. Plants on the forest floor grow in still weaker light.

This reduction of light by a canopy of vegetation is very important ecologically, particularly if reduced to 20 per cent or less. It is, moreover, extremely difficult to isolate and evaluate the influence of the light--or light reduction--factor. Other factors, such as wind, relative humidity, soil moisture and temperature, also vary directly with reduction in solar light intensity.

Illumination within a forest stand is constantly fluctuating. Under a canopy of vegetation, rapid variations take place in the amount of light energy received at any given point. This is a result of wind movement of leaves and small branches in conjunction with hourly variations in the movements of light beams and shadows. Thus light intensity at a leaf surface may rise abruptly from 2 per cent to 35 per cent for a few minutes and then drop back again. These rapid fluctuations of illumination intensity associated with wind influence, angle of the sun's rays, difference in time of day and of season, and effects of weather, make measurement of light intensity difficult and single measurements meaningless.

Sunlight influences transpiration. Light stimulates the guard cells to open and increases permeability of the plasma membranes. Accordingly, transpiration increases rapidly at daybreak, but shows a very low level at sundown. Solar radiation is absorbed by the plant and causes it to heat. The plant is also affected by outside agencies such as air movements which themselves have internal temperature characteristics. The solar radiation absorbed in the plant must be studied in conjunction with the effects on it of these outside temperature elements. In other words, because heat influences transpiration and other physiological processes, the study of radiation as an ecological and micro-climatological element is very complicated.

The Temperature Element

Although the absolute value of the temperature within the forest is directly influenced by the prevailing airmass, it is the radiation relationship or pattern which determines the forest temperature at particular levels. The hourly change in temperature distribution within a forest stand is mainly determined by the denseness of the stand, that is, the degree to which it allows direct solar radiation to penetrate to the floor of the forest. At sunrise, the coldest temperature in an old and dense stand is at the crown. Here, maximum heat loss through long-wave radiation occurs. The warmest level is in the vicinity of the forest floor.

Following sunrise, the air immediately above the crown begins slowly to warm. The rate gradually increases in direct proportion to the angle of solar radiation. In an hour, the temperature at this level may be 5°C higher than that within the stand--where a uniform temperature has generally prevailed for practically the whole night. By mid-morning the temperature within the crown space will have equalled that of the layer immediately above it and by midday will surpass it. The dense crown canopy now absorbs the noon radiation to greater depths. Simultaneously the lower layers of the forest, as the angle of the sun's rays approach the normal, begin to share in the day's heat. But this gain in heat is small. The

sinking cool outer air, mixing with the air of the trunk space, has a moderating effect. Thus, by midday, the highest temperatures are found in the crown space, with a thin turbulent zone immediately above, in the free air. At the same time the lowest temperatures are found in the trunk space below.

During the second half of the day the reverse temperature trend follows the same course as the morning rise. As the air cools in the crown space it sinks, becoming stratified at ground level. The morning heating must overcome the stability of the nocturnal temperature stratification; the evening cooling is furthered by establishment of this stable stratification.

At night the temperature gradient within a closed stand is practically nil. The whole layer of air is isothermal or, if the crown canopy is sufficiently dense, colder air will often remain on top of the crown cover. In less dense stands, however, the sinking cold air from the crown space results in a temperature minimum at the forest floor. In such a condition, a double minimum of temperature may be observed; one at crown surface, the other at floor level. Similarly, during midday heating, within a thin stand where solar radiation reaches the forest floor in quantity, a second weak maximum of temperature occurs at the forest floor as well as at the crown level.

The Relative Humidity Element

Absolute humidity within a forest stand will be governed greatly by the prevailing airmass. On the other hand, relative humidity will display a pattern comparable to that described for temperature.

The vertical distribution of relative humidity shows patterns appropriate to the particular time of day. The relative humidity at all levels is usually high prior to sunrise. The occurrence of dewfall is a good indicator of past relative humidity. It is found mainly on the upper surface of the tree crown in old and dense stands, where it decreases gradually into the inside of the stand. To complete the evaporation of dew in the crown often requires several hours of sunshine.

In thin stands, where an overnight temperature minimum occurs at ground level, good dewfall results. The time required to completely evaporate this will be much greater than for dew at the crown level. This time difference results from the limited amount of illumination and the smaller prevailing vapor gradient existing at the lower levels.

As the sun gets higher and the wind freshens, a more thorough mixing takes place between the outer free air and the crown space air. The drying processes which are present slowly penetrate into the interior of the stand. The midday forest atmosphere now receives water vapor chiefly from two layers: first, the crown canopy of the forest with its countless transpiring leaves or needles; second, the forest floor cover.

Although the latter cover plays only a subordinate role in respect to temperature, it is very important for the transfer of water vapor. The relative humidity is generally higher at this level within a dense stand if a living plant cover exists.

The midday pattern of relative humidity, because of these two water vapor sources, displays two maximum levels. The lower level is caused by moisture evaporating from the forest floor; the higher by evapo-transpiration from the crown foliage.

Extent of evaporation, at the floor levels in the standing forest, depends on the degree of development of the ground flora and the openness of the stand. The lack of air movement in the space around the trunk results in a retention of the water-vapor, so that together with the lower temperature, high relative humidity is the most characteristic feature of its micro-climate. Drying out occurs chiefly in the upper portion of the crown space where higher daytime temperatures are favourable to lower relative humidity. Drying will also occur at ground level. In this case, the crown space must be sufficiently open to permit an abundance of solar radiation to reach the floor surface. Moreover, sufficient ventilation to aid in maintaining the necessary vapor gradient must be achieved.

The Wind Element

It is known that wind speed within the surface layers of the atmosphere is subjected to frictional drag at ground or tree-top level. This decrease is considerable. Within a stand an astonishingly uniform, gentle, air movement usually prevails from the lower limits of the crown space to just above the ground. Below the one-metre level the wind speed is near zero. The greater part of the wind's kinetic energy is, therefore, like radiant energy: it is consumed mostly at the crown of the forest with only a small part affecting the ground layers. These variations of wind speed are extremely important in assessing any particular level within a stand, as they affect its ability to retain or lose moisture through evaporation.

THE INFLUENCE OF THE FOREST ON ITS OWN ENVIRONMENT

In discussing the climatic elements controlling the aerial environment of the forest stand, little has been said about the influence of a growing forest on its own micro-climate. On its emergence from the ground a small seedling is no longer passively subjected to the micro-climatic conditions, but helps actively to form them. As the seedlings grow into small trees, the air near the ground becomes less disturbed. The plants themselves in absorbing solar radiation, indirectly change the temperature regime in the very low levels. This temperature change, together with an increase of water-vapor through transpiration and evaporation of the dewfall, causes an increase in the relative humidity. Furthermore, as a result of insufficient ventilation, this high measure of relative humidity is maintained.

Amounts of solar radiation reaching the lower levels within a forest stand are governed by the variations in the forest's crown canopy. The resulting differences cause, directly or indirectly, variations in other micro-climatic elements, such as temperature, humidity, evaporation and transpiration. The influence of a growing forest in changing its own micro-climate, and the effect this has on its constituent species may be seen in the operation of plant succession.

Aspen and birch are easily propagated and readily become established in burned-over land. The open crown canopy of these deciduous species makes for a favorable change in the micro-climate. This permits growth of a species such as spruce, tolerant to shade and the new climatic environment. Spruce will in time eventually grow beyond the aspen and birch, resulting in decreased illumination at their level of foliage. As aspen and birch are intolerant to shade, they gradually die, and spruce becomes the climax species.

Then, too, the micro-climate of a "frost pocket" can be changed sufficiently to grow certain commercial conifers. This is done by first growing poplars as a nurse crop. The crop will grow to a height which will eventually impede cold air drainage and reduce the outgoing heat from the forest floor levels. The micro-climate, changed in this manner, permits planting light-frost intolerant conifers. When these have grown sufficiently to protect themselves against this form of frost, the poplar may be cut out. This leaves a more or less pure stand of good commercial conifers in what initially was a "frost pocket".

OROGRAPHIC INFLUENCES ON THE AERIAL ENVIRONMENT OF THE FOREST

Very often the micro-climate of a locality is greatly influenced by its proximity to mountain ranges, valleys and lakes, from where winds peculiar to the time of day carry extraneous influences. This is particularly true of night winds, which gravitate into the low valleys in a slow, steady stream. Areas where flowing air is quite noticeable will have, through local turbulence and vertical mixing, a higher overnight minimum temperature and a correspondingly lower maximum relative humidity. Conversely, in localities where the air flow is practically nil, temperatures are much lower and the relative humidities near 100 per cent.

Heavy dewfall is very often observed in these areas--a phenomenon in determining climate. Dewfall, as a form of precipitation, may not be significant, but the period of dewfall and the short interval following it, are measures of the time when reserve moisture is not subject to evaporation.

The mountain valley "thermal belt" is another example of a locality dependent upon an extraneous influence for its micro-climate. This past summer, a technique was devised for locating this zone, using smoke generators. This particular technique was used to determine the height of the "thermal belt" in the Kicking Horse Valley on the westerly slope of

Cathedral Mountain. It was found to be approximately 5,500 ft. ASL. This level is important: it is here that the average frost-free period is longest, mean overnight minimum temperatures highest, maximum overnight relative humidities lowest, and dewfall least frequent. Consequently, at this level, plants sprout earliest in the spring, damage due to late frosts is slightest, yet forest fire danger is greatest due to negligible overnight recovery of moistures. Moreover, this level provides one of the best habitats for insect survival and reproduction.

CONCLUDING OBSERVATIONS

Young forests may develop on large cultivated areas. In this case, they are subject to local micro-climatic conditions as are agricultural crops. Or they may grow from natural seeding or plantation by foresters, at the edge, or in the midst of, the mother forest.

The forest is continually subject to weather damage from wind, frost, snow, desiccation and other agencies. The extent of this damage will vary with the existing micro-climate and the location and condition of the forest stand itself. Fire danger is determined largely by the percentage of moisture within the forest fuels, resulting from the integrated effects of the micro-climatic elements. Therefore, the practising forester must understand the micro-climatology of his district, in order to reduce damage by weather, fire or insects to a minimum.

Today in Canada, micro-climates are being investigated to an ever-increasing extent by foresters, entomologists, agriculturists, and other scientists. They are finding that techniques learned from general climatology are applicable to only a limited extent.

The essential principles of micro-climate can be applied to forest areas generally and be studied successfully in appropriate experimental areas. Thus, we find the Fire Research Section of the Forestry Branch carefully selecting its experimental areas so as to study micro-climatic elements where these are associated with fuel moisture and fire danger. You will find, too, the entomologist simultaneously observing the life cycle of the insects in a particular locality and local micro-climatic influences on them.

Though only two examples have been given of this form of research, they do show that micro-climatology occupies a special position in the realm of natural science, being closely associated with many kindred sciences.

It is of the greatest importance to the development of micro-climatology that future research be conducted under the largest possible variety of conditions. To do this efficiently and economically, I suggest that some agency or institution is needed to undertake direction and co-ordination of scattered individual experimentation.

REFERENCES

Methods in Climatology	Conrad and Pollack
Physical and Dynamical Meteorology	Brunt
Plants and Environment	R. F. Daubenmire
Plant Sociology	Brown, Blanquet, Fuller and Conrad
Plant Communities	H. J. Oosting
The Climate Near the Ground	Geiger