Some Factors Affecting the Commercial Value of Spruce Wood ...

by

Irene Mounce, B.A.

SOME FACTORS AFFECTING THE COMMERCIAL VALUE OF SPRUCE WOOD.

---

by

Irene Mounce, B.A.

A Thesis submitted in conformity with the requirements for the degree of Master of Arts in the University of British Columbia.

May, 1920.

SOME FACTORS AFFECTING THE COMMERCIAL VALUE
OF SPRUCE WOOD.

This work was begun two years ago when the Imperial Munitions Board was engaged in obtaining Picea sitchensis for aeroplane manufacture. Many o the trees supplied proved unable to stand the various physical tests applied them in the Timber Testing Laboratory here in Vancouver, and a microscopic in vestigation was undertaken to try and locate the defects. In this, fungus infection very often proved to be responsible for the rejection of a tree. But fungous infection was frequently associated with irregularities in the an ual growth, or with an abnormal number of resin ducts; so that eventually th work was narrowed down to an attempt to establish some relationship between t yearly increase in diameter and the number of resin ducts present in that ann growth on the one hand, and the weather conditions of that year on the other.

rce of
erial.

As has been said material for the first part of the investigation was obtained through the Imperial Munitions Board, and later through the Domi Timber Testing Laboratory here. The greater part of the fifty odd specimen of spruce examined was from the Queen Charlotte Islands, Prince Rupert, and t North end of Vancouver Island, with five trees from Kings, near New Westmins B.C. These specimens were numbered in the order in which they came in, wi out reference to defects.

od.

In dealing with the specimens, blocks of suitable size were cut, th boiled in water to drive the air from the cells. From these blocks microto sections of about 35-40 microns in thickness were cut in three planes; i.e. transverse - or across the grain, longitudinal radial - parallel to the direct of the medullary rays, and longitudinal tangential - or at right angles to the medullary rays, or parallel to the annual rings. These sections were staine with safranin and if they were to be examined for fungus hyphae, they were cou er-stained with methylene blue.

mary
d
rvations.

The trees had been culled for various reasons, but principally becau
- (a) they were short fibred, i.e. they would not yield a long splinter.
- (b) They "checked" or split especially along the line of the annual rings.
- (c) Very often they were merely discolored and to a woodsman looked "unhealthy".

rt
red
ber.

(a) The spruce which was designated as "punky" short-fibred or "brash" usually showed in transverse section a large annual growth with a very small p portion of summer wood i.e. there were comparatively few of the cells with hea ily lignified walls. Hence the specimens lacked the strength of ordinary spruce for as Gerry (1) stated: "Late wood was found to be about twice as stro

(a).
as early wood, although the fibre was some 12 per cent. shorter". Often too the longitudinal sections showed cells with more or less blunt or square ends, instead of the long pointed end characteristic of the wood tracheid. This too would tend to reduce its tensile strength.

(b) In the specimens with "ring-check" the splitting was usually due t sudden and excessive yearly growth for one or several seasons, and the wood usually checked where the marked increase began. In one or two cases the cause of the checking was found in the presence of an unusual number of resi ducts in a season's growth. This was especially noticeable in specimens No. 19 and No. 20.

In No. 19 there were rows of resin ducts irregularly scattered through two year's growth. The ducts were large, tyloses abundant, and surrounding them were irregularly grouped parenchyma cells. These as well as the resin ducts and the cells of the uniseriate rays were filled with a deeply staining resin-like substance which caused a dark line along the wood for those two annual rings.

No. 20 showed a row of resin ducts similar to that in No.19, but it occurred in a year's growth where rotholz was present. RThe resin ducts with their parenchyma cells were so numerous that in longitudinal section all the cells in that region seemed square-ended parenchyma cells. According to Jeffrey[2] even in Conifers where ligneous resin canals are entirely absent from the secondary wood, they occur after injury and the genus Cedrus is strikingly distinguished by the fact that it produces both horizontal and vertical resin canals resulting from injury. Hartig[3] describes the same condition; i.e. an excess of resin ducts in wood that has been attacked by Agaricus. In several cases of abnormal growth, fungus was present and often fungus where the resin ducts were so numerous. But whether the resin ducts were caused by the attack of the fungus or merely offered it an easy means of access is still to be determined.

(c) The discolorations in wood, as far as could be ascertained, were principally due to the presence of resin ducts, rotholz, or fungus. A plethora of resin canals causes, in transwerse sections, a dark line quite often visible to the naked eye. In several specimens a whole "ring" was dark and rather irregularly stained, while the adjoining ones were quite normal in appearance. Sections of that type of wood showed the presence of rotholz which Lee[4] describes thus, "Under exceptional conditions, apparently when the wood is compressed as it is forming, the fibres develop remarkably heavy walls. Because of the reddish color af this type of wood has been named "Rotholz". The single tracheid from such an area may be recognized by the spiral striations which appear to represent the method in which the walls of the tracheid are formed. The pits in such a tracheid usually exhibit long slit-like openings and the walls themselves seem often to be spirally split." According to Miss Gerry[1] the rotholz is much stronger than the ordinary wood or "Zugholz". In the case of those trees examined for the second part of the work when rotholz was found in those trees which had grown unevenly, or were "off-centre" it was found most abundantly on the side of the tree on which most growth had taken place. (Whether this holds true in general, I do not know). This larger side was also the side exposed to the prevailing winds, in the only two cases where such data was available.

acteria.

Bacteria were isolated from two badly discolored specimens No. 2 and No. 14. No. 2 came from a raft of timber which had been too long in transit and fungous decay had set in. Spores appeared over the surface of the timber and specimen No. 2 was from the heartwood of one of the infected planks. It showed an abundance of fungus mycelium and from it was isolated a bacillus of the colon-typhoid group, most probably B. cloacae. This in itself was of no particular import. Schmitz[5] came to the following conclusions in regard to the relation of bacteria to cellulose fermentation induced by fungi. "(1) Cellulose dissolving bacteria play no important part in the decay of wood under natural conditions. (2) The results from the decaying experiments tend to indicate that the rate of decay may be materially increased by the presence of the ordinary saprophytic bacteria. (3) The influence of bacteria on fungi with reference to the rate of decay induced by the fungi varies with the different fungi on different woods."

No. 14 however, was a part of a stick of timber which, in falling from the truck to the ground, broke transversely, leaving a rough irregular surface but did not splinter. It was discolored and showed yellow or ting es of red. Though many series of sections were made, no fungus hyphae were found. But from it were isolated three common organisms Staphylococcus albus, Sarcina lutea, and Bacillus megatherium. To do this, small blocks of the wood were charred in a flame, then with sterile scalpel, pieces were cut from the centre of the block and placed in tubes of sterile brot In twenty-four hours a heavy flocculent growth appeared. From this cultur the various organisms were easily separated by plating in the usual way on beef peptone agar.

Two attempts were made to reinoculate the isolated organisms into spruce blocks. Blocks 2" x 2" x 6" were flamed and set in sterile petri dishes under a bell jar. 5 cc. of a pure broth culture of one of the organisms, was put in each of the petri dishes, and the blocks left in a fairly warm dark place. It is not surprising that fungus growth soon appeared, and the experiment proved a failure. Three of the blocks were then removed from under the bell jar placed in covered sealers containing two inches of sterilised water, and put in a dark room. About a year later they showed a splendid growth of the white felt-like mycelium of Merulius lacrymans and even produced sporophores. These were somewhat dwarfed and abnormal as is usual when a fungus is grown under unnatural conditions.

It was clear that a more thorough sterilization was essential. Autoclaving would have been preferable but Schmitz[6] had already shown that when wood is sterilised by autoclaving it undergoes certain changes which must be considered when using wood for experimental purposes with decaying fungi. Among these changes are (a) a change in color, (b) an increase in the amount of reducing substances in the extract, (c) an increase in the acidity of the extract, (d) an increase in the hydrogen ion concentration of the extract, (e) a change in resistance towards decay. On learning a dry heat of 100°C for one hour will not injure the strength of timber, we placed wood blocks, similar to those used in the previous experiment, in petri dishes, plugged the top of the bell jar with cotton wool and passed three glass tubes, one reaching to each petri dish, through the plug. These small tubes too were plugged with cotton wool. After sterilisation for one hour at 100°C. in a hot air steriliser, 5 cc. of a young broth cultur of one of the isolated strains of bacteria were poured through the glass tube into each petri dish. The top of the glass tubes were flamed and replugged. This method seemed fairly satisfactory for some time. The block inoculated with Bacillus megatherium showed color changes for at least two inches up the sides, staining a bright yellow to orange and red. Late however, fungus appeared and the apparatus was simply allowed to stand in a dry, warm place. At the end of a year all but two of the blocks were discarded because mycelium was showing on the surface of the block. Only those inoculated with B. megatherium and Proteus vulgaris were sectioned. The former showed spores grouped around the bordered pits and filling the cell ends, but af often happened before, these seemed to wash out before the sections could be run up through the alcohols and mounted. Many combination stains were tried and the spores showed up especially well with the safranin haematoxylin method as recommended by Jeffrey[7] but did not show in the permanent mounts. These spores appeared to be identical with those in a smear made from the culture of megatherium with which the wood was inoculated. Tubes of broth inoculated with flamed pieces of the infected blocks yielded a pure culture of B. megatherium. Proteus too, was recovered but not in pure culture. Unfortunately, microtome sections showed fungus present in both blocks, but the experiment does prove that bacteria with and without spores can exist in comparatively dry wood for at least one year, that they do cause discoloration in wood and shows that with prope care, inoculations of that type might be accomplished and the effect of bacteria working alone on the cellulose structures, might thus be ascertained.

ungus.

But in most cases discoloration seemed to be accompanied by fungus growth. Not that the extent of discoloration indicated the spread of fungus hyphae, but rather that a great deal of discoloration suggested a badly infected piece of timber. The fungus appeared as more or less branched non-septate hyphae passing from cell to cell through the cell wall itself or through a bordered pit. This showed especially well in sections stained in safranin and counterstained in methylene blue, just long enough to stain the fungus hyphae and not long enough to mask the brilliant red of the cellulose in the tracheid walls. One specimen was somewhat different from the rest. It was badly checked and discolored, and section showed hyphae which were much heavier than usual, that passed through many cell walls and were profusely branched and bore at the tips of short branche numerous little bulbous outgrowths like haustoria. Months later two block were cut from this wood and planed. One was charred on the outside, the other treated with mercuric chloride then sterile water. Each one was pla in a pint sealer containing 100 cc. of sterile water. Within a month myce ial growth was evident on both blocks and conidia had been formed in abundan

It is obvious that identification of the fungus was impossible wit nothing but the hyphae to work on. As a rule no definite information abou the wood was obtainable except the assurance that the tree would not have been cut if any sporophore or irregularity of any kind had been present on the outside of the trunk.

The specimens of infected spruce No. 10, No. 11, and No. 30 showed the cellulose lamella badly broken up though the lignified parts seemed to remain intact. Other badly infected pieces No. 40, No. 28, and No. 29, showed tracheids containing a gelatinous like lining which stained quite deep ly with methylene blue. In this lining, openings could easily be seen in line with the position of the bordered pits in the lateral walls - an occurrence of which no other record has been found.

The last fifteen trees examined proved to be even more interesting They consisted of three groups of five trees each, selected by experts as being the best specimens of *Picea sitchensis* obtainable in a certain chosen district. No fungus was found in any sections of the trees that came from the farthest north. Of the five from Southern British Columbia, three wer definitely attacked by fungus and the other two were questionable; while those from the third district showed fungus present in them all, though in varying degrees.

It was rather startling to find that in cutting the trees in Southern British Columbia, two of the ones originally chosen were very badly infected with heart rot of some kind, and lying beside the stumps of the seven felled trees was an uprooted spruce which showed near the butt, almost complete rotting of the heartwood. Evidently infection takes place through the roots, for the amount of decay decreases rapidly from the butt upward.

II. As has been said, the second part of the work was an effort to establish some relationship between the amount of yearly growth and the numb er of resin ducts in that year's growth, and the temperature and precipitati as recorded for that year.

terial.

For this, trees were obtained from three regions (1) Prince Rupert (Tree II) where there is a heavier rainfall, (2) Oyster Harbor (Trees III, IV, and V), five miles north of Ladysmith, Vancouver Island, where the rainfall is comparatively light but heavier than in the surrounding districts which are too dry to permit the growth of spruce. (See map p.199, Report of Committee on Conservation -Forests of British Columbia, Craig and Whitford). (3) University Site, Point Grey, Vancouver, (Trees I and VI) where the rainfall is practically intermediate between the other two places. Two trees were obtained from Vancouver, one from Prince Rupert, and two from Oyster Harbor. A more detailed description of them will be given below.

Tree I was a Sitka Spruce from Point Grey (Vancouver, B.C.), about thirty feet from Marine Drive, and within a stone's throw of the salt water, though several hundred feet above it. The tree was four and three-fourth inches in diameter and showed forty growth rings. For the first thirty years, the annual growth was very small. This was probably due to unfavou able surroundings and not to rainfall and temperature variations. The tr was always off centre, the large growth being towards the north-west, and after 1909 this was still more accentuated. In 1909 (as nearly as could be ascertained), Marine Drive was cut through, giving the tree access to much more light.

Rotholz was present, though almost exclusively on the larger side o the tree and was probably due to the effect of the winds which came from that direction. The tree was protected from the wind on the remaining three sides by other trees.

Tree II was a Sitka Spruce from Prince Rupert. Sections from the base, middle and tip of the tree were obtained and microtome sections were cut from the middle section. At this point 92 growth rings were present and the tree was fifteen inches in diameter. It was characterised throughout by an extremely even and regular annual growth and looked like a splendid specimen of Picea sitchensis, but nothing whatever is known of edaphic conditions.

Trees III and IV were specimens of Sitka Spruce from Oyster Harbor. These samples were cut from two green trees, 200 feet from the west line and 250 feet from the north line on Lot 22, Oyster District, near Ladysmith, B.C. No. 1, sample (butt) was cut 30 inches from the ground, No. 2, sample, 25 feet, and No. 3, sample, 60 feet. The smaller sample X1 (butt) 3 feet from the ground, X 2, 24 feet, and X 3, 55 feet. The land on which these trees grew lies about half a mile from the salt water and is a heavy black loam with clay bottom, with a stream running close by. There is about 32 per cent. spruce, 35 per cent. cedar and the balance hemlock and fir on this area.

Tree III, is sample No. 2 of the larger tree cut 25 feet from the ground. It was approximately eleven inches in diameter and showed 120 annual rings. For the first fifty years, growth was about 2 mm. each year with apparently the same amount of summer wood in each ring. In the next sixty years, growth was just as regular, but only half as great, while for the last ten years, the amount of growth was so small as to be difficult to distinguish with the naked eye. These changes evidently are not dependent on precipitation and temperature changes, for in the four years for which data is available, marked variations occur, yet the growth curves show little modification.

Trees IV and V. Tree V is simply the centre section of the same tree as IV (marked X 1 butt.). Their conditions and environment were the same as those of tree III. Tree IV was 9½ inches in diameter and somewhat off centre. The larger side was characterised by the presence of a good deal of "rotholz". Growth for the last few years was exceedingly small and irregular on the four sides A.B.C.D.

A.- 1915 - 11, all have two growths of summer wood.
B.- 1919 - 18, 2 growths of summer wood.
    1917- 09, Rotholz.
C.- 1915-12, two growths of summer wood.
    1911 - Small yearly growth as A, but only one row of summer wood.
D.- 1916 and 1912 - have two growths of summer wood.
    1911 - small as in other sections.

Tree V, or the central part of same tree.

A. 1915, and 1913 - 2 growths of summer wood.
B. 1915, 2 growths of summer wood.
C. 1915, and 1913, 2 growths of summer wood.
D. 1915 2 growths of summer wood.

This tree at this point was 8 inches in diameter and had rotholz present as in tree IV.

Tree VI. was a Sitka Spruce from the University Site, Point Grey, Vancouver. It grew in a hollow and in 1912 the higher land above it was cleared; in 1916 the land directly in front of it was slashed, and in 1917 tile drains were put in. It was 13 inches in diameter and showed 90 growth rings at the height where sections were cut. The early growth was very small, from 1908-1912 it was extraordinarily large and from 1913-1919 much smaller, but still larger than the average.

Methods. Sections were cut from four regions (labelled A.B.C.D.) in each year's growth for the last ten years, 1918-1909. Five measurements of each year's growth in each of the regions A.B.C.D. were made with a micrometer eye piece affixed to a rotating stage microscope. These five measurements were expressed in millimeters, averaged, and the average taken as the growth of the tree for that year.

For the resin ducts the number in each region A.B.C.D. was counted. Ten counts were made of the number of resin ducts in 5.3 mm. of each region. These were averaged and the average taken as the number of resin ducts in section A.B.C. or D. The averages for the four sections then obtained were averaged and this result was taken as the average number of resin ducts in 5.3 mm. of the year's growth.

Data for precipitation and temperature was obtained from Bulletin No. 27, editions I-IV, issued by the Department of Agriculture of the Provincial Government, on the climate of British Columbia. Graphs were made of the annual average temperature and yearly rainfall for the years 1909-18, and others of the rainfall and average temperature for approximately the months of the growing season,-i.e. from the first of March to the end of October.

Resin Ducts.

The number of resin ducts in the different trees varies so much and there seems to be so little in common that each tree will be treated separately

sin
cts.

__Tree I.__ __Occurrence.__ As the accompanying graph shows, there is extreme variation both in the number and position of resin ducts in this tree. There is usually a larger number of them occurring on one side of the tree but hardly ever on the same side for two years in succession.

__Precipitation.__ With the exception of the year 1912, the resin duct curve seems to indicate an increase in number of resin ducts with a decrease in amount of precipitation; that is when the precipitation curve for the growing season, March to October, is used. The 1912 exception may be largely discounted too, when one notices the excessive number in section C which raises the average. The relation between the two curves is especially well marked in the years 1914-1918.

1915 a drop in precipitation, increase in number of resin ducts.
1916 highest precipitation during period 1909-1918, fewest resin ducts.
1917 decrease in precipitation, increase in number of resin ducts.
1918 further decrease in precipitation, increase in number of resin ducts.

__Temperature.__ There is little variation in the average temperature for the months of the growing season, so little that it could hardly be said to be responsible for the great variation in the number of resin ducts. The highest average temperature during 1909-1918 occurred in 1915 and this was coupled with a low precipitation in that year. A large number of resin ducts appeared in that year's growth.

__Tree II.__ The resin ducts present in the Prince Rupert tree are almost negligible for the average number present in 5.3 mm. of a year's growth is 0-3.5 and for six of the ten years under consideration, the average ranges from 1.5 -1.75 resin ducts in 5.3 mm. of a year's growth.

<u>Precipitation</u>. Yet the same feature is found as in Tree I, namely in the year of greatest precipitation resin ducts were entirely absent.

1911 with the lowest temperature during the eight years for which information is available and a medium precipitation for that district, results in the largest average (except that of 1918).

1912 with the lowest precipitation and a comparatively high temperature has fewer resin ducts than the previous year.

1913 combines an average temperature and an excessive rainfall with the complete absence of resin ducts - the only time during the years 1909-1918.

1914, the temperature is slightly higher and the rainfall during the growing season is somewhat less with an increase in the number of resin ducts.

<u>1915, 1916 and 1917</u> show a steady decrease in the amount of precipitation and a slight increase in temperature yet no variation in the number of resin ducts.

1918, with an increase in rainfall and a slight increase (if any) in temperature, has the largest number of resin ducts for the period 1909-1918.

The precipitation curve for this district is extremely variable- showing marked changes from one year to the next. It would appear that here, at least, resin duct formation is not greatly influenced by rainfall changes. This may perhaps, be accounted for by the fact that, though there is a great variation yet the minimum average yearly rainfall is so much above the minimum required by spruce (42) that the variation from 90-126 inches matters hardly at all. Again if the theory that a high precipitation results in few resin ducts be true, then where the minimum average annual rainfall is about 90 inches one would scarcely expect many resin ducts.

<u>Tree III</u>. Information regarding weather conditions for this district can only be obtained for the years 1914-1918. As a general rule, there are very few resin ducts in the years examined. 1913 and 1914 are exceptions to this and they are marked by a large number on two sides of the tree with comparatively few on the remaining sides. Although, of course, this increases the average for those years, the resin ducts may be in response to some other stimulus entirely. If so, then 1914 would probably have shown very few ducts since there is a comparatively high precipitation.

1915 with a decrease in the amount of precipitation and a slight rise in temperature shows a decrease in the number of resin ducts.

1916-1917 shows first an increase then a decrease in average rainfall with a slight decrease then increase in temperature, while the resin duct curve shows a slight decrease for both years. Here, at least within limits, the number of resin ducts is not directly dependent on the rainfall or temperature.

1918 shows an unusual decrease in precipitation and marked rise in temperature accompanied by an increase in the number of resin ducts.

<u>Tree IV</u>. This tree shows a variation from 0-4 resin ducts per 5.3 mm. with a marked absence of them in 1909-1915. The average line for the year is greatly influenced by the fact that first one side, then the other develop far more resin ducts than the remaining three sides. With the exception of 1918, alternating increase in the various sides is approximately the same.

1914-1917 -during this period the precipitation and resin duct lines show the same tendencies, a decrease from 1914-1915 and increase from 1915-1916, a decrease from 1916-1917 while the temperature rises slightly. 1918, as usual, shows a marked decrease in rainfall accompanied by a corresponding increase in the number of resin ducts - due though almost entirely to an extraordinary number on one side (B).

<u>Tree V</u>. (Central section of same tree as IV.). This section shows a variation of from 6.5 - .075 resin ducts per 5.3 mm. of a year's growth, with practically none in the year's 1909-1916.

During the years 1914-1917 the resin duct line is the reverse of the precipitation line i.e. a heavy precipitation is accompanied by few resin ducts and vice versa.

1914-15,	Decreased precipitation, increased number of resin ducts.
1916	Increased precipitation, decreased number of resin ducts.
1917	Decreased precipitation, increased number of resin ducts.
1918	Decreased precipitation, decreased number of resin ducts.

1918, as usual, behaves differently. In this year a small rainfall occurs, yet there are few resin ducts nor does the distribution - if one may call it so - of the rainfall explain this; for furing April, May, and June, the total rainfall was less than one-fourth of the usual average for these months; July and August were above the average, and September and October only half the usual rainfall for that period. 1916 shows much the same distribution, the rainfall for the months of May, June, July and August are above the average and few resin ducts occur in that year. In the years 1915 and 1917, on the other hand, July and August were much drier than usual and more resin ducts occurred. Unfortunately, 1914 has as few resin ducts as 1916 and 1918, yet in that year May, July and August were much drier than the average and the theory that a wet summer produces few resin ducts, and a dry one, many seems somewhat upset.

Tree VI. Although this tree was subjected to such varied conditions, the resin duct curve is comparatively steady; it shows a variation of from .3-4.5 resin ducts in 5.3 mm. of a year's growth. The decided variation in precipitation from year to year seems to have little effect.

1900, Decrease in precipitation, decrease in the number of resin ducts.
1911, Decrease in precipitation, increase in the number of resin ducts.
1912, Increase in precipitation, increase in the number of resin ducts.
1913, Marked increase in precipitation, increase in resin ducts, (slight).
1914, Decrease in precipitation, increase in the number of resin ducts (slight).
1915, Decrease in precipitation, decrease in the number of resin ducts.
1916, Heaviest precipitation, fewest resin ducts.
1917, Decrease in precipitation, increase in resin ducts.
1918, Decrease in precipitation, increase in resin ducts.

Seeming incongruities may be somewhat accounted for by the fact that the growth for 1909-1912 was at least twice as great as that from 1912-1918. In 1912 the land above the tree was cleared, leaving the tree with less moisture and more or less stagnant water. Tile drains were put in in 1917 and the land immediately around was slashed in 1916, the year in which the growth increased.

lusions.

The position of the resin ducts in a year's growth varied almost as much as the number; some were found in the early spring growth and others at the end of the summer growth, yet they most frequently occurred either at the beginning of the summer wood or scattered in the spring wood.

From the data given above it seems evident that the presence of resin ducts, except in cases of very heavy or very low precipitation cannot be counted as dependent either on temperature or rainfall, but other factors must be taken into consideration. This is still further evident when we recall (1) That resin ducts occur as a traumatic response to unfavourable stimuli - (Jeffrey)

(2) That identical weather and temperature conditions will have such a varied effect on trees growing close together such as Tree I and Tree VI.

(3) That two sections of the same tree will show such a varied response to the same stimule (IV and V). In these trees 1909 is the only year where they agree. They show then an almost entire absence of resin ducts. The other years are all characterised by a very large number of ducts on one side, but this side is first one, then the other, not even following a regular sequence, and what is more, in no year do you find the excessive number of ducts on the same side of the tree in the two sections of the same tree i.e. IV. and V. In tree IV the resin duct curve follows the precipitation curve until 1917, when a decrease in rainfall is associated with an increase in the number of resin ducts. Tree V on the other hand, shows a resin duct curve which is the opposite of the rainfall curve until 1917 and in this year a decrease in rainfall is associated with a decrease in the number of resin ducts.

__Tree III__ which is from the same region as the other two, still further complicates matters by having practically no resin ducts in the years under consideration, 1914-1918. The few present give a curve which follows the precipitation curve for 1914-1915, and does not for 1916, does for 1917 and does not for 1918.

So that for three trees from the same region under the same conditions, we have three different resin duct curves.

From a comparison of the curves of the number of resin ducts and the average temperature (annual, or for the growing season) temperature does not seem to be a limiting factor, except that a very hot summer may increase the effect obtained by little rainfall.

rowth.

__Growth__. From a general survey of the growth curves of the six trees examined, it would seem that the total annual rainfall and the average annual temperature had locally little effect on the growth for each year.

In Tree II, from Prince Rupert, the growth curve shows none of the marked variations which occur in the rainfall curve; e.g. in 1912 there was a light rainfall for that district; in 1913 an exceedingly heavy one, yet the growth curve is seemingly unaffected. In fact, for the ten years under consideration there is no variation.

As for the trees from Oyster Harbor, the variation in growth from year to year is so extremely small that the experimental error might easily account for the slight variations, e.g. tree III shows the following variations in growth.

1914 - a decrease of .052 mm.
1915 - an increase of .007 mm.
1916- a decrease of .006 mm.
1917- an increase of .013 mm.
1918- an increase of .059 mm.

If these measurements can be taken as a basis for deductions, the results are rather more confusing. For though Trees III, IV and V grew under identical weather and temperature conditions, the slight differences show that growth for the same year in the same tree is not always equal. For the three trees the same results i.e. a decrease or increase in amount of growth occur only once during the five years.

Trees I and VI behave somewhat differently.

In Tree I, 1912-1918, the average yearly growth curve follows fairly closely that for the total annual precipitation, especially in 1915, when with a low precipitation and high temperature a comparatively small growth occurs, and in 1916 and 1918 when a steady increase in average annual growth is combined with a steady increase in the total annual rainfall. The temperature factor does not seem to enter except in conjunction with precipitation, in fact it seems almost apparent that a heavy annual rainfall is associated with a low average annual temperature and a light rainfall with a high one.

In Tree VI evidently the growing conditions of 1909-1912, whatever they were, were particularly favourable for the growth of Spruce. The growth curve for those years does not vary with precipitation; e.g. 1911-1912 shows an increase in precipitation and decrease in growth; in 1912 the very large growth ceases and this is most probably accounted for by the clearing of the height of land just above the hollow where the tree was growing. This supposedly cut off the steady supply of water and allowed what water there was to collect around the tree. From 1913-1918 the annual growth is still very large as compared with that of the other trees. Of these years, 1917 and 1918 are the only ones in which the growth curve follows the rainfall curve; here an increase in the amount of rainfall is accompanied by an increase in the amount of growth.

From a comparison of the growth curves and precipitation curves it would seem that the increase or decrease in total annual rainfall corresponds more closely to the changes in the growth curves than does the increase or decrease of the rainfall curve for the growing season,(March - October). At least it satisfies a larger percentage of cases, though the amount of increase in precipitation does not govern the amount of increase in yearly growth.

One graph was triedtaking the rainfall during each of the ten months of the growing season (here, February to November) and trying to establish some connection between distribution of rainfall and the amount of growth. At least in Vancouver, the distribution of the rainfall has little or no effect on the average annual growth of Sitka Spruce. In two years when the amount of growth showed a decrease from that of the preceding year, the rainfall was well distributed throughout the summer. On the contrary, in 1915, which gave the longest dry spell during the ten years, the growth was greater than that of the preceding year.

According to Craig and Whitford[3], Sitka Spruce is fairly tolerant of shade and excessive moisture and grows in districts with an average rainfall of from 42 inches to 112 inches. Yet the mature tree is not so shade-enduring and grows rapidly under favourable light conditions. It would see then, that in the tree from Prince Rupert, since the annual rainfall is so heavy, even the minimum rainfall there is so much above the minimum required by spruce, evidently here the water factor is not a limiting one; but rather the amount of growth is limited by the amount of sunlight, which is relatively small, and by a short growing season. At Oyster Harbor, on the other hand, the average annual rainfall is so close to the minimum required for Spruce that a large annual growth could hardly be expected even with the other favourable conditions such as sunlight and a relatively long growing seaso In Vancouver, the rainfall is amply sufficient, as much and more than that of the Queen Charlotte Islands (52.25 inches), and combined with this are a lon growing season and plenty of sunlight, in contrast with the long periods of cloudy weather which occur in the Queen Charlotte Islands. This might account for the large growth in the trees for Vancouver in contrast with the small amount in those from Prince Rupert and Oyster Harbor.

From the work done so far one would conclude that within the range where water is not a limiting factor in the distribution of Sitka Spruce (i.e in districts having a rainfall of 42 inches to 112 inches), in different localities any of several different factors may prove to be the controlling one with reference both to resin ducts and the amount of growth per year. Growth in the tree from Prince Rupert showed no effect of the variation in amount of rainfall, and the long periods of cloudy weather may be held responsible for the small yearly growth. At Oyster Harbour, on the contrary, the water factor probably is the controlling factor. The trees were provided with plenty of sunlight, a relatively long growing season, but just a little more than the minimum amount of rainfall which permits spruce to grow. Though trees I and VI were grown under identical temperature and rainfall conditions, neither of these factors seems to be responsible for the variatio in growth. In tree VI the marked decrease in growth (1912) was evidently due to changes in drainage, while the change in tree I (1909) was no doubt caused by the increased amount of light accessible when Marine Drive was cut through.

In dealing with the resin ducts no comparison of the relative number in the trees from various localities could be made; with the exception that the tree from Prince Rupert showed fewer resin ducts and a more regular distribution of them than any of the others. It seems true also, that a large increase in amount of rainfall tends to decrease the number of resin ducts, but the converse does not always hold. Otherwise, one is led to believe that there is some specific controlling factor which causes a large number of resin ducts to appear now on one side of a tree, now on another, without any apparent sequence.

It is readily seen that the various factors that have been considered affect the commercial value of Spruce in one way or another. Timber that "checks" easily, whether from irregular growth or a surplus of resin ducts must be discarded in any work of value. Short fibred wood like that with a large amount of spring growth has not the required strength and its uses are, therefore, limited. The deletorious effects of fungus on all wood from pulp wood to the finest standing timber is too well known to require comment.

The most valuable spruce timber has a long fibre, straight grain and a relatively large proportion of summer wood. Judged on this basis, trees I, IV, V and VI would not make a favourable showing, for their irregular growth, with rotholz freely interspersed, and cross grain make these trees of little commercial value. Trees I and VI have the additional disadvantage of a high percentage of spring wood. Tree II and to a less extent III, form a sharp contrast to the others and conform to the requirements. These were the qualities which led the Imperial Munitions Board to come to Northern British Columbia for their supply of aeroplane Spruce.

R E F E R E N C E S.

1. Gerry, E.- Fibre measurement studies length, where they occur and their relation to the strength and uses of wood.
   Science, Vol. 61, No. 1048, Page 179. 1915.

2. Jeffrey, E.C.- The Anatomy of Woody Plants.
   University of Chicago Press, Page 74, 344-335.

3. Hartig, R. Lehrbuch- Baumkrankheiten. 1889.

4. Sec, H.N.- Douglas Fir Fibre, with special reference to length.
   Forest Quarterly, Dec. 1916.

5. Schmitz,- The Relation of Bacteria to Cellulose Fermentation induced by Fungi, with Special Reference to the Decay of Wood.
   Annals of the Missouri Botanical Garden, 6; 93-137, April 1919.

6. Zeller, S.M.) Schmitz, Henry) Duggar, B.M.) Growth of wood-destroying fungi on liquid media.
   Annals of the Missouri Botanical Gardens 6; Page 137-140, April 1919.

7. Jeffrey, E.C.- The Anatomy of Woody Plants.
   University of Chicago Press, p. 457.

8. Craig and Whitford- Forests of British Columbia.

TREE	YEAR	SECTION	AVERAGE ANNUAL GROWTH FOR SECTION	FOR YEAR	AVERAGE NO. OF RESIN DUCTS FOR SECTION	FOR YEAR
			m.m.	m.m.		
: Picea sitchensis (Point Grey). 918-1909.	1913	A	3.80		5.1	
		B	1.64	2.65	6.6	
		C	2.13		.0	3.27
		D	3.03		1.4	
	1912	A	4.30		6.2	
		B	2.18	2.80	1.3	9.95
		C	2.21		32.3	
		D	2.52		.0	
	1911	A	3.82		3.7	
		B	1.81	2.82	5.1	4.27
		C	2.99		2.5	
		D	2.66		5.8	
	1910	A	3.38		5.3	
		B	1.54	2.30	7.6	3.02
		C	2.69		.0	
		D	1.59		1.2	
	1909	A	2.41		.0	
		B	1.25	1.58	.0	1.6
		C	1.64		.0	
		D	1.02		6.4	

TREE	YEAR	SECTION	AVERAGE ANNUAL GROWTH FOR SECTION	FOR YEAR	AVERAGE NO. OF RESIN DUCTS FOR SECTION	FOR YEAR
			m.m.	m.m.		
I Picea sitchensis (Point Grey) 1918-1909.	1913	A	3.80		5.1	
		B	1.64	2.65	6.6	
		C	2.13		.0	3.27
		D	3.03		1.4	
	1912	A	4.30		6.2	
		B	2.18	2.80	1.3	9.95
		C	2.21		32.3	
		D	2.52		.0	
	1911	A	3.82		3.7	
		B	1.81	2.82	5.1	4.27
		C	2.99		2.5	
		D	2.66		5.8	
	1910	A	3.38		5.3	
		B	1.54	2.30	7.6	3.02
		C	2.69		.0	
		D	1.59		1.2	
	1909	A	2.41		.0	
		B	1.25	1.58	.0	1.6
		C	1.64		.0	
		D	1.02		6.4	

TREE	YEAR	SECTION	AVERAGE ANNUAL GROWTH FOR SECTION	FOR YEAR	AVERAGE NO. OF RESIN DUCTS FOR SECTION	FOR YEAR.
II icea itchensis	1918	A	.883		.2	
		B	.758	.79	2.8	2.55
		C	.626		2.6	
		D	.926		2.8	
	1917	A	1.128		.1	
		B	.931	1.01	3.6	1.4
		C	.834		.7	
		D	1.166		.3	
	1916	A	.834		1.7	
		B	.739	.76	.4	1.5
		C	.650		1.4	
		D	.836		2.5	
	1915	A	.813		.0	
		B	.606	.69	3.4	1.45
		C	.596		.0	
		D	.764		2.4	
	1914	A	.741		2.7	
		B	.626	.66	1.1	1.55
		C	.599		1.1	
		D	.710		1.3	

REE.	YEAR.	SECTION.	AVERAGE ANNUAL GROWTH. FOR SECTION	FOR YEAR.	AVERAGE NO. OF RESIN DUCTS. FOR SECTION /	FOR YEAR.
I icea itchensis	1913	A	.591		.0	
		B	.475	.51	.0	.0
		C	.518		.0	
		D	.509		.0	
	1912	A	.631		.3	
		B	.507	.56	1.2	1.35
		C	.628		3.4	
		D	.524		.5	
	1911	A	.831		2.8	
		B	.635	.65	.0	1.77
		C	.566		.3	
		D	.585		4.0	
	1910	A	.635		.2	
		B	.564	.59	.0	.47
		C	.622		.7	
		D	.579		1.0	
	1909	A	.694		.0	
		B	.537	.60	.0	1.25
		C	.636		.0	
		D	.576		.5	
	1908	A	.496		2.9	
		B	.543		0.	1.2
		C	.637	.55	.8	
		D	.528		1.1	
	1907	A	.527		.5	
		B	.576	.55	11.4	3.4
		C	.631		1.2	
		D	.515		.5	

E.	YEAR.	SECTION.	AVERAGE ANNUAL GROWTH. FOR SECTION	FOR YEAR	AVERAGE NO. OF RESIN DUCTS. FOR SECTION	FOR YEAR.
	1918	A	.252		.9	
nsis r		B	.230	.25	.0	.85
r) 908		C	.234		.5	
		D	.302		2.0	
	1917	A	.212		.1	
		B	.176		.0	.025
		C	.158		.0	
		D	.22	.191	.0	
	1916	A	.168		.0	
		B	.183	.178	.4	.125
		C	.183		.3	
		D	.175		.3	
	1915	A	.186		.3	
		B	.208	.184	.0	.075
		C	.140		.0	
		D	.204		.0	
	1914	A	.196		11.4	
		B	.192	.177	.0	.392
		C	.154		.0	
		D	.181		4.3	

...	YEAR.	SECTION.	AVERAGE ANNUAL GROWTH. FOR SECTION.	FOR YEAR.	AVERAGE NO. OF RESIN DUCTS. FOR SECTION.	FOR YEAR.
EX.	1913	A	.188		.3	
ensis er		B	.316	.229	12.8	5.4
er) 1908.		C	.212		5.5	
		D	.502		3.0	
	1912	A	.164		.7	
		B	.196	.218	1.0	1.87
		C	.315		4.6	
		D	.197		1.2	
	1911	A	.209		1.6	
		B	.155	.17	.0	.65
		C	.135		.0	
		D	.188		1.0	
	1910	A	.196		1.6	
		B	.180	.218	.0	1.47
		C	.209		.9	
		D	.229		3.4	
	1909	A	.192		.0	
		B	.180	.20	7.3	2.2
		C	.233		1.5	
		D	.196		.0	
	1908	A			.3	
		B			.0	1.07
		C			.7	
		D			3.3	

.	YEAR	SECTION.	AVERAGE ANNUAL GROWTH. FOR SECTION	FOR YEAR.	AVERAGE NO. OF RESIN DUCTS. FOR SECTION.	FOR YEAR.
.	1918	A	.179		.0	
ensis		B	.290	.217	16.1	4.27
ter oor)		C	.241		1.	
-1908.		D	.161		0.	
	1917	A	.168		4.2	
		B	.435	.207	1.1	1.32
		C	.144		.0	
		D	.197		.0	
	1916	A	.191		.2	
		B	.374	.202	.3	1.82
		C	.199		.0	
		D	.155		6.8	
	1915	A	.217		.6	
		B	.413	.272	.0	.03
		C	.273		.0	
		D	.200		.6	
	1914	A	.270		1.8	
		B	.441	.387	1.1	2.42
		C	.379		6.8	
		D	.467		.0	

E.	YEAR.	SECTION.	AVERAGE ANNUAL GROWTH. FOR SECTION	FOR YEAR.	AVERAGE NO. OF RESIN DUCTS FOR SECTION	FOR YEAR.
.	1913	A	.213		.9	
nsis		B	.550	.330	.4	2.22
r						
or)		C	.270		1.2	
908.						
			.290		6.4	
	1912	A	.370		1.1	
		B	.612	.382	.2	1.22
		C	.351		1.3	
		D	.200		2.3	
	1911	A	.209		.0	
		B	.766	.313	7.6	1.9
		C	.123		.0	
		D	.155		.0	
	1910	A	.295		1.9	
		B	.139	.213	.0	.65
		C	.174		.3	
		D	.246		.4	
	1909	A	.397		.6	
		B	1.086	.480	.0	.15
		C	.209		.0	
		D	.229		.0	
	1908	A			.0	
		B			5.2	
		C			.0	1.3
		D			.2	

TREE.	YEAR.	SECTION.	AVERAGE ANNUAL GROWTH. FOR SECTION.	FOR YEAR.	AVERAGE NO. OF RESIN DU FOR SECTION.	FOR YEA
V. a	1918	A	.180		.2	
hensis e as No.IV		B	..274	.247	.0	.375
er Harbor) -1908.		C	.168		.9	
		D	.369		.4	
	1917	A	.143		.0	
		B	.167	.147	15.0	6.525
		C	.143		.0	
		D	.137		11.1	
	1916	A	.201		.0	
		B	.131	.305	.0	
		C	.151		.0	.075
		D	.738		.3	
	1915	A	.146		.0	
		B	.324		1.6	1.775
		C	.205	.216	3.4	
		D	.192		1.1	
	1914	A	.168		.0	
		B	.176	.203	.0	.325
		C	.217		.0	
		D	.254		1.3	

TREE.	YEAR.	SECTION.	AVERAGE ANNUAL GROWTH. FOR SECTION	FOR YEAR.	AVERAGE NO. OF RESIN DUCTS. FOR SECTION	FOR YEAR.
e V. ea chensis me as No.) ter Harbor) 8-1908.	1913	A	.348		.0	
		B	.270		.20	5
		C	.201	.257	.0	
		D	.188		.0	
	1912	A	.307		.0	
		B	.258	.273	.4	.95
		C	.155		.0	
		D	.375		3.4	
	1911	A	.422		.0	
		B	.242	.249	.5	.125
		C	.201			
		D	.134			
	1910	A	.647		16.9	
		B	.225	.406	.4	4.4
		C	.161		.0	
		D	.594		.3	
	1909	A	.631		.0	
		B	.303	.418	.0	
		C	.287		.0	.2
		D	.451		.8	
	1908	A			9.4	
		B			2.2	3.45
		C			.0	
		D			2.2	

'REE.	YEAR.	SECTION.	AVERAGE ANNUAL GROWTH. FOR SECTION	FOR YEAR	AVERAGE NO. OF RESIN DUCTS. FOR SECTION	FOR YEAR.
VI :ea :tchensis ›int Grey) 18-1908.	1918	A	3.67		3.9	
		B	2.57	3.12	1.3	2.30
		C	3.66		3.7	
		D	2.58		.3	
	1917	A	3.44		1.4	
		B	1.64	2.36	.0	.47
		C	2.46		.5	
		D	1.91		.0	
	1916	A	2.29		.6	
		B	1.28	1.51	.0	
		C	1.33		.6	.3
		D	1.16		.0	
	1915	A	2.66		.0	
		B	1.64	1.88	.0	
		C	1.89		3.0	1.75
		D	1.36		4.0	
	1914	A	2.30		1.2	
		B	1.76	1.87	3.9	2.55
		C	2.01		.3	
		D	1.44		3.7	

REE.	YEAR.	SECTION.	AVERAGE ANNUAL GROWTH. FOR SECTION	FOR YEAR	AVERAGE NO. OF RESIN DUCTS. FOR SECTION	FOR YEAR
I ea chensis int Grey) 8-1908.	1913	A	2.30		1.2	
		B	3.12	2.62	3.8	2.15
		C	2.96		1.6	
		D	2.13		2.0	
	1912	A	7.47 m.m.		2.7	
		B	5.95 m.m.	6.21	6.9	4.55
		C	7.24 m.m.		5.2	
		D	4.20		3.4	
	1911	A	8.54		2.8	
		B	5.95	6.91	1.7	3.90
		C	7.58		2.0	
		D	5.6		10.1	
	1910	A	8.52		3.5	
		B	5.76	7.09	4.0	2.8
		C	8.04		3.7	
		D	6.06		.0	
	1909	A	7.96		.6	
		B	6.68 m.m.	7.67	1.3	3.57
		C	8.66		12.2	
		D	7.38 m.m.		.2	
	1908	A	7.14			
		B	4.00	6.19		
		C	7.82			
		D	5.80			

n c o u v e r. TEMPERATURE AND PRECIPITATION. 1918 - 1906.

perature.

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	AVERAGE.
40	37	41	49	54	61	64	62	60	51	43	38	50
34	35	39	46	54	57	63	64	58	50	48	39	48
26	37	42	48	52	60	61	63	57	47	40	34	47
38.2	42.5	47.7	52.0	56.2	60.4	64.7	65.6	57.9	50.9	41.7	39	51.4
40.5	38.7	44.9	50.6	56.4	58.7	63.5	61.8	54.8	52.5	44.5	36.4	50.3
32.5	35.8	39.7	48.3	53.8	59.2	62.9	62.8	55.5	47.6	42.4	40.1	48.4
37.4	40.9	41.2	47.9	56.1	60.5	63.6	61.5	56.5	48.0	43.8	39.3	49.7
32.6	36.6	42.9	44.9	52.2	57.2	63.9	62.0	56.0	49.7	39.9	38.7	48.0
36.0	34.6	44.5	47.2	56.0	57.1	62.8	59.8	57.5	50.4	42.8	41.0	49.1
29.2	39.2	41.4	45.0	51.4	58.2	60.5	59.6	56.5	49.6	42.4	33.9	47.2
38.1	38.4	41.6	46.5	51.2	58	63.5	61.9	54.1	47.9	45.5	36.1	48.5
27.3	37.6	39.5	45.6	55.6	58.9	63.7	60.7	57.1	50.4	44.6	39.4	48.4
38.7	39.8	42.7	49.8	53.9	56.9	66.9	62.3	55.7	50.2	40.8	38.6	49.6

cipitation.

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	YEAR.
11.04	10.56	7.47	1.70	1.15	1.00	2.29	4.59	0.30	7.56	7.03	8.07	62.71
9.33	5.87	5.61	8.20	1.69	5.40	0.48	0.93	3.30	3.49	5.23	11.72	61.25
5.96	7.40	14.55	4.07	1.41	1.34	5.25	0.58	1.28	2.16	6.37	5.71	56.08
7.13	4.42	4.18	3.04	3.42	1.07	0.91	0.36	0.80	8.83	5.41	10.36	49.93
10.56	4.87	3.33	3.28	0.74	3.58	0.42	0.75	6.86	6.37	10.18	2.84	53.78
9.62	4.28	5.37	2.53	4.33	3.81	2.02	0.85	3.89	6.19	10.08	3.95	56.92
8.47	6.25	0.89	3.92	2.35	2.28	1.54	5.86	2.84	4.64	9.21	8.80	57.05
6.11	3.37	3.05	1.96	5.39	2.09	0.92	1.23	4.41	2.24	12.68	8.82	52.27
10.47	3.30	2.91	3.60	2.15	1.98	0.24	1.38	2.47	9.04	10.62	8.79	56.95
4.58	8.15	4.14	1.30	3.76	1.69	2.45	1.43	2.23	7.06	15.66	4.10	56.61
7.60	5.98	7.14	2.61	4.41	1.86	1.59	1.15	1.46	6.77	13.69	8.41	62.37
7.32	8.05	2.39	4.13	1.44	1.43	1.70	1.36	4.51	1.76	13.23	7.96	55.28
9.29	6.03	2.37	1.04	3.58	3.04	0.45	0.83	8.87	7.00	8.25	6.78	58.31

Prince Rupert. TEMPERATURE AND PRECIPITATION - 1918 -1908.

Temperature.

R	Jan.	Feb.	Mar.	April.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	AVERAGE
8	38	33	35	41	45	52	58	56	56	48	40	36	44.8
7	31	33	336	43	48	51	54	57	54	46	46	31	44.1
6	21	36	38	43	47	53	55	58	49	47	40	32	43.2
5	41.2	39.9	46.4	44.6	53.0	54.0	58.0	60.2	54.7	46.6	39.0	37.7	47.9
14	35.7	40.5	42.9	46.8	49.8	54.9	54.9	56.2	51.9	51.6	41.0	35.2	46.8
13	29.2	37.5	37.4	42.9	48.6	56.0	56.2	58.0	53.3	45.1	42.6	41.3	45.7
12	34.5	41.6	40.7	43.10	52.3	52.6	57.5	55.1	54.8	48.2	41.1	38.8	46.7
11	26.0	34.5	37.0	38.1	46.0	49.8	56.4	57.0	55.3	48.4	36.9	37.0	43.5
10	33.1	32.8					54.8	55.1	50.8	46.7	38.9	39.8	
09	23.2	32.9	39.0	40.2	46.6	57.8	54.7	53.6	53.6	46.1	36.8	31.6	42.5
08								56.0	50.6	44.1	41.4	36.5	

Precipitation.

AR	Jan.	Feb.	Mar.	April.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.	YEAR.
18	10.92	5.56	9.13	4.86	7.13	4.75	5.09	8.38	2.20	14.84	10.20	10.61	93
17	10.18	6.09	5.70	4.91	1.54	6.80	3.75	4.57	7.05	11.19	21.66	9.94	93.
16	3.14	6.92	10.8	6.20	5.63	5.46	5.00	4.94	9.22	13.44	15.45	8.34	94
15	12.95	7.57	10.57	12.50	3.07	5.63	1.28	6.75	9.66	17.08	11.77	11.64	110
14.	6.36	10.24	9.13	9.10	6.43	1.68	17.25	4.16	10.19	11.87	11.91	6.56	104
913	11.33	5.73	14.11	8.86	6.75	3.56	7.73	5.08	13.74	15.91	14.60	19.08	126
912	4.41	8.50	2.75	8.66	2.94	4.09	3.44	4.70	8.39	12.41	13.52	16.21	90
911	15.30	7.09	19.92	8.64	4.38	5.29	6.04	3.67	4.28	7.49	8.40	13.19	103
910	4.69	6.72					4.50	4.83	8.60	18.13	9.17	24.64	
909	9.39	8.98	9.64	6.29	8.07	3.31	7.70	9.98	19.99	19.17	7.40	3.88	106
908								3.40	20.35	18.02	13.36	8.42	

L a d y s m i t h, B.C.--- TEMPERATURE AND PRECIPITATION. 1918-1014.

Temperature.

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	AVERAGE
40	36	41	49	54	62	64	62	62	50	42	38	50
33	35	39	44	52	56	63	66	57	50	46	38	48
25	37	41	47	53	60	60	64	57	48	39	34	47
35.6	40.6	46.6	50.7	54.5	59.5	63.2	66.1	57.9	50.6	39.9	37.5	47.4
34.6	39.4	40.4	44.4	48.5	53	56.6	54.4	50	48.8	40.4	35.5	45.5

Precipitation.

Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	YEAR.
7.97	5.16	7.73	.60	.42	.25	1.01	1.65	10	3.52	7.77	6.83	57.
3.75	5.05	4.86	7.27	1.02	1.82	22	.45	2.39	.36	3.82	12.21	48
10.97	6.60	7.87	2.14	1.60	1.59	1.84	1.35	1.16	4.09	4.42	7.33	52
5.67	3.31	4.91	1.83	3.12	1.09	.54	.21	.28	7.92	5.57	12.15	43
17.34	4.40	2.55	3.85	.31	2.1	.38	.07	4.48	10.26	10.71	1.69	43