SOME NOTES ON THE PERIODICITIES OF CERTAIN INSECTS IN RELATION TO THE SUN SPOT CYCLE

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This paper is but a brief summary of some of the known facts regarding sun spots and a comparison of some of our insect periodicities with those of the sun spot cycle.

Although astronomical observations were recorded by the Chinese as far back as 2136 B. C., (Chambers 1909) the first authentic record of a sun spot is dated 188 A. D.

The nature of sun spots has been described by Dr. DeLury of the Dominion Observatory as whirling storms on the sun, much like a cyclone on the earth. Some of these are as large as our earth, others ten times as large. A spot the size of our earth, however, in comparison to the sun, would be no more than a trivial blemish on the solar disc. The centrifugal force of the whorl decreases the pressure at the centre and slightly cools the hot gas, giving it a darker centre. These spots have long been known to vary in number from year to year. Statistics procured over a long period of time show that they reach a maximum in number periodically from 9 to 14 years with an average cycle of 11.5 years. Since the sun is fundamentally responsible for our weather, it is plausible that the type of weather we experience should vary with the sun's condition. Data from Australian rock deposits 200 million years old, layers of clay deposited each spring for thousands of years, growth rings in trees in California and Arizona, all indicate that the sun has been following this regular cycle with varying degrees of intensity all that time.

Sun spots are, apparently, indications that the sun is undergoing an increased activity and that the unspotted area is giving off more heat than usual. It is, therefore, the condition of the sun, and not the spots themselves, that produces changed conditions on the earth during sun spot years.

Recent discoveries show that during sun spot years the area of the sun surrounding these spots is higher in solar atmosphere and that it is emitting a larger amount of ultra-violet light, which is frequently 75 percent greater and sometimes double when spots are numerous than when scarce. Sun spot years are therefore sun-burn years. Ultra violet light is known to liberate electrons from gases of low pressure, and this is what apparently happens to the upper atmosphere of the earth, which in turn becomes electrified during maximum sun spot years. This causes disturbances in various electromagnetic phenomena and is evidenced by auroral displays and disturbances in terrestrial magnetism, telegraphy, radio, etc. Further, an electrification of the atmosphere results in the formation of ozone which exerts an absorption of solar radiation. It also induces the formation of cloudiness where water vapor is present.

Generally speaking, cloudiness and sun spots vary directly, whereas temperatures vary inversely. Hence, maximum sunspot years are accompanied by a maximum of clouds and a minimum of mean temperatures; while minimum sun spot years are accompanied by higher temperatures and greater transparency of the atmosphere. St. John's, Newfoundland, for example experiences a 20 percent greater rainfall during years of maximum sun spots. On the other hand, there are exceptions to this general rule. During minimum sun spot years, the greater transparency of the atmosphere and higher temperatures produce a greater evaporation on coastal points and this frequently precipitates inland. Thus Edmonton shows as much as 50 percent greater rainfall during the minimum years than at the maximum of sun spots. The greater atmospheric transparency of minimum sun spot years results in more rapidly rising air currents and quicker evaporation, thus producing more thunderstorms. Toronto, for example, shows 30 percent more thunderstorms during the minimum sun spot years.

In general, we may say that the sun spot cycle is accompanied by variations in the sunlight received, electromagnetic conditions, chemical compounds, and transparency of the atmosphere, temperature, cloudiness and precipitation. It would be logical, therefore, to look for some variation in the condition of life in general, in accordance with fluctuations of the physical elements by which they are controlled. The periodicities of certain insects and diseases are definitely correlated with weather, but records correlating life in general with the sun spot cycle are all too scarce. Possibilities in this direction are suggested by a study of grasshopper outbreaks.

One of the first attempts to correlate the grasshopper cycle with sun spots was made by A. H. Swinton in England in 1878. Criddle, (1932) published a homogeneous record of grasshoppers, grouse, and rabbits recorded in Manitoba between the years 1895-1929. The relation between their abundance and sun spots was shown graphically and in all cases, their numbers varied directly with the sun spots.

In considering the grasshoppers, Criddle mentioned that grasshoppers are probably kept in bounds by natural enemies and meteorological factors, but one would not expect to find grasshoppers subject to both at the same time, for weather adverse to grasshoppers probably would be detrimental to their natural enemies. In Manitoba, the higher temperatures, early spring and intermittent thundershowers accompanying the minimum sun spot period seemed most beneficial to the grasshopper population. This condition, he found, occurred during thirty-two grasshopper outbreaks.

In an analysis of conditions as recorded in British Columbia during the past outbreaks, dating from 1889 to 1934, a rather striking similarity is shown, particularly in the Nicola country, as illustrated in the accompanying graph. The maximum outbreaks, apparently, have accompanied the sun spot minimum. Since these early records are only approximate, the fact that the peak occurs a year before or after the minimum is of little consequence. Further, although a slight increase is shown for 1906, near a sun spot maximum, the record for this year is dubious, and is based on the memory of certain inhabitants. There was no real epidemic that year.

Records from the Chilcotin country show a marked regularity, but at a different phase of the sun spot cycle than in the Nicola. An examination of the graph shows that the maximum years of grasshopper outbreaks occur, in a general way, between the maximum and minimum sun spot years, with the exception of the years between 1913-17 and the present outbreak. Such variations, however, might be the result of other disturbing factors and, according to E. R. Buckell, the present epidemic might well be influenced by over-grazing.

Factors which might contribute to the difference between the Nicola and Chilcotin outbreaks are far beyond the scope of this paper, but certain observations of Criddle in Manitoba might be of interest. Grasshoppers appear in a variety of habitats, from moist regions to the most arid. In two such regions, an annual precipitation double the normal would have very different effects. In the normally moist area, it might cause a heavy mortality, where in the arid region, it might be ideal for vegetation and also grasshoppers. The optimum rainfall for development would be the same in both places; although occurring in different phases of the sun spot cycle. He further points out that where grasshoppers are controlled by natural enemies, their increase is often first recorded at a phase of the sun spot cycle which, though perhaps less suitable for development, is free of natural enemies.

Bodkin (1929) has listed the years of maximum outbreaks of locusts in Palestine, from 1865-1928, and although he made no mention of sun spots, the accompanying graph shows their correlation in a marked degree, with the exception of 1928.

In so far as other insect outbreaks in British Columbia are concerned, data on hand is much too scarce to attempt a correlation with sun spots. Nevertheless, we have definite dates for the past three peaks of bark beetle outbreaks. These occurred about 1911-13, 1921-23 and 1931-33. The first two reached their peaks at the sun spot minimum, the latter about a year prior to the minimum. The periodicities of the

Hemlock Looper, **Ellopia somniaria** Hulst., show no apparent relation to the sun spot cycle, although it is hard to tell whether the earlier reference to this insect in British Columbia referred to small local infestations or general outbreaks.

While the data contained in this paper is of a limited nature, Dr. DeLury has stressed the value of any records on wild life which may help in presenting a comprehensive picture of the response of weather and living things to the astranomical cycles in various parts of Canada.*

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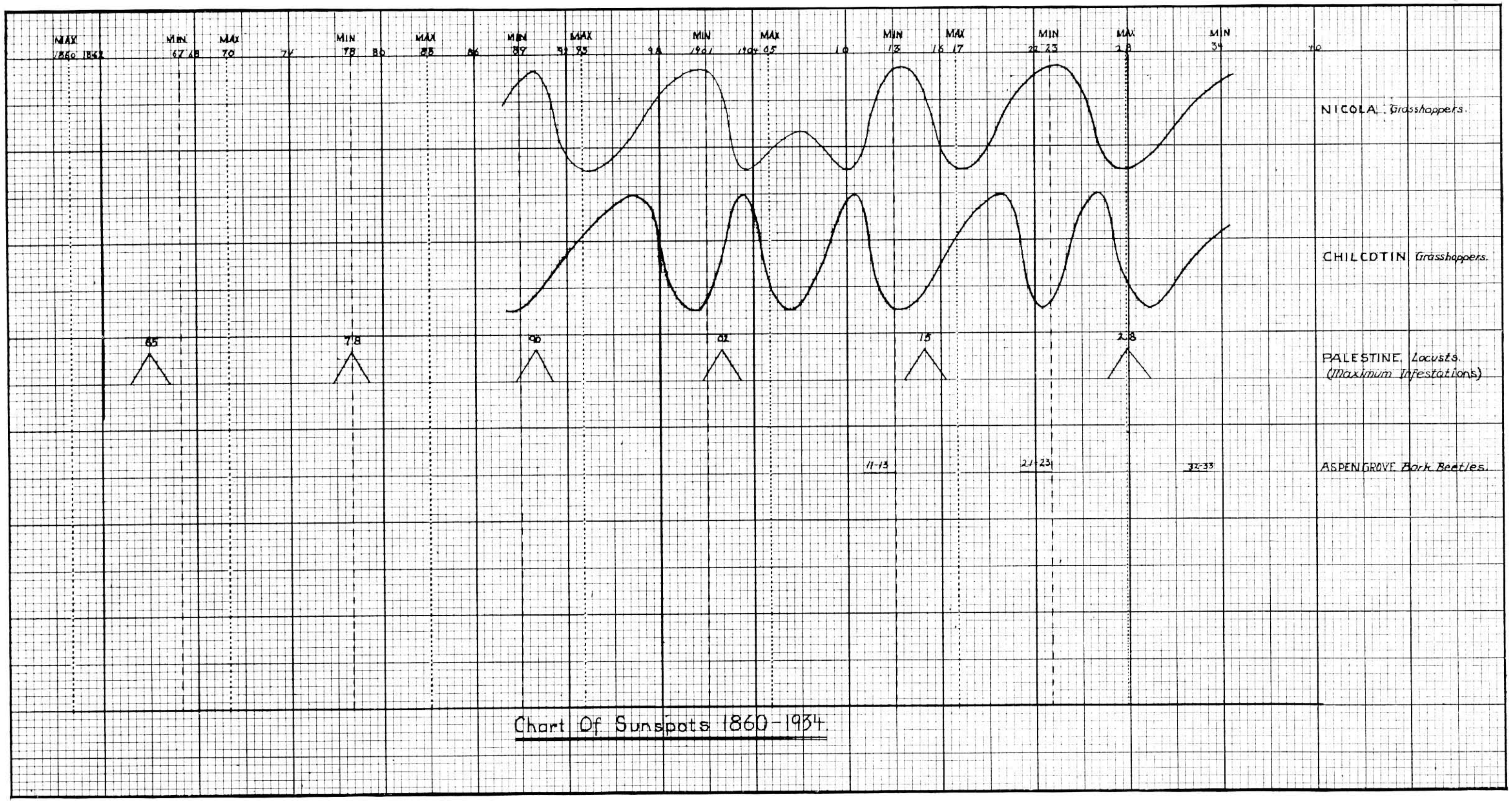
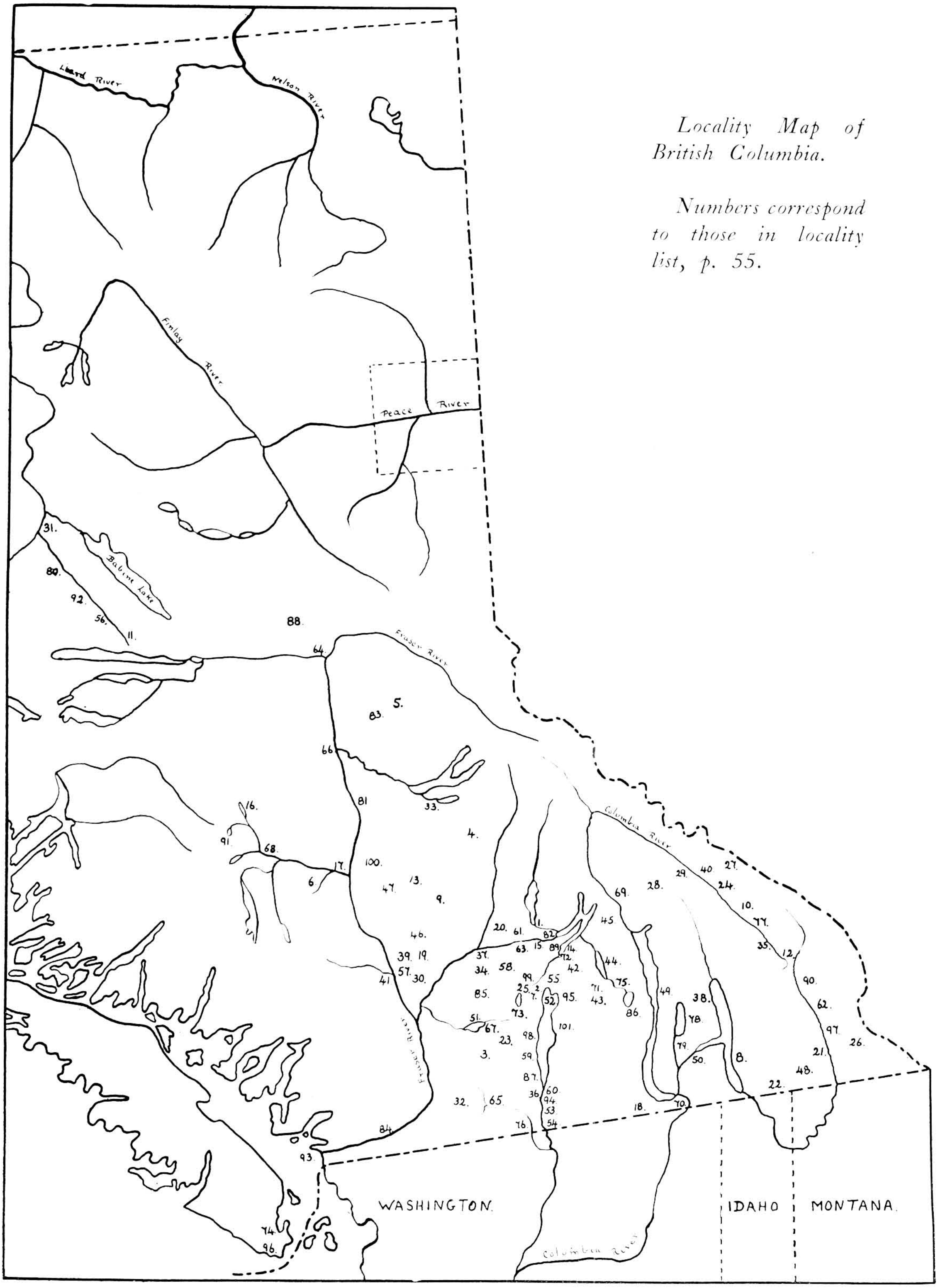
*Editor's Note: It has been pointed out by other writers that the present data with regard to insect outbreaks and sun spot cycles is far too meagre to preclude coincidence or chance.

CORRELATION OF SUN SPOT CYCLES AND SOME INSECT EPIDEMICS





Locality Map of British Columbia.

Numbers correspond to those in locality list, p. 55.