DEVELOPMENT OF DOUGLAS-FIR SEED AND POLLEN CONES

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Introduction

Douglas-fir is a very important timber species on the West Coast of North America and, – as an introduced exotic, – in many parts of Europe. Its reproduction is of great importance to the forest manager. Since reproduction is solely dependent on seed production it is understandable that much effort has already been spent on the investigation of flower bud initiation and subsequent development. In this report we intend to discuss the initiation and development of the micro- and mega- sporangiate strobili of Douglas-fir.

Previous Work

Several workers have studied initiation and development of lateral buds of Douglas-fir. Allen (1941) stated that differentiation takes place about the time vegetative growth ceases, and reproductive buds are clearly distinguishable from vegetative buds towards the end of August. Allen (1963) reported further that – in general, – ovulate strobili can be recognized in July. Allen (1946) indicated the hypodermal origin of the micro- and mega- sporangium.

Sterling (1946) described the changes in the vegetative apex in the course of a year, and later (Sterling, 1947) discussed initiation of lateral vegetative buds.

Recently Owens and Smith (1964) investigated the initiation and differentiation of the three different kinds of lateral buds. Their results indicated that the foliar initiation commenced in mid-July, They followed the subsequent development of the lateral buds during their entire life cycle and described the changes in detail.

Materials and Methods

To further elucidate the differentiation of the reproductive organs, five trees were selected (23, 29, 35, 115 and 129) in the U.B.C. Research Forest, Haney and another tree (E) was chosen on the University Campus, Vancouver. Twigs were collected weekly between June 16 and August 10, 1965 inclusive but no collection was made on June 23. The top third of the trees was sampled. We found that the least complicated way of approach was the old fashioned method of climbing. The twigs were defoliated and killed and

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fixed in Newcomber's solution right after collection. This kill-and-fix agent has the advantage of containing acetone which promotes more efficient and quicker penetration. This is important with coniferous material which has resin in it. The twigs were stored in the same solution in a refrigerator until needed.

Previous collections were also available for our use. One had been used by Allen (collected from 1957 to 1961). Unfortunately, these buds were picked from different trees and therefore comparison was not possible. They also seem to have dried out somewhat during the storage period and sectioning of them was very difficult. The other collection for our disposal was made in 1964 in the U.B.C. Research Forest in Haney, from the same trees as sampled in 1965 but these buds were virtually all vegetative, correctly forecasting a poor seed production year for 1965. For these reasons we had to be content with studying only twigs collected in 1965.

We grouped buds according to their position on the twigs. The first, second and third laterals (from the tip of the twigs) are very often females while the laterals closer to the base are mostly males. First and second laterals were put in one group and laterals from the fifth position on were put in the other.

Embedding was carried out as follows: buds were detached from the twigs and washed thoroughly in 70% EtOH, followed by the dehydration and paraffin infiltration procedures described by Johansen (1940). Microtome sectioning was done on a rotary microtome to give 12-15 microns thickness. The sections were triple stained in tannic acid – ferric chloride combination, safranin and fast green as was suggested by Kuijt (personal communication). Canada balsam was used as the sealing medium.

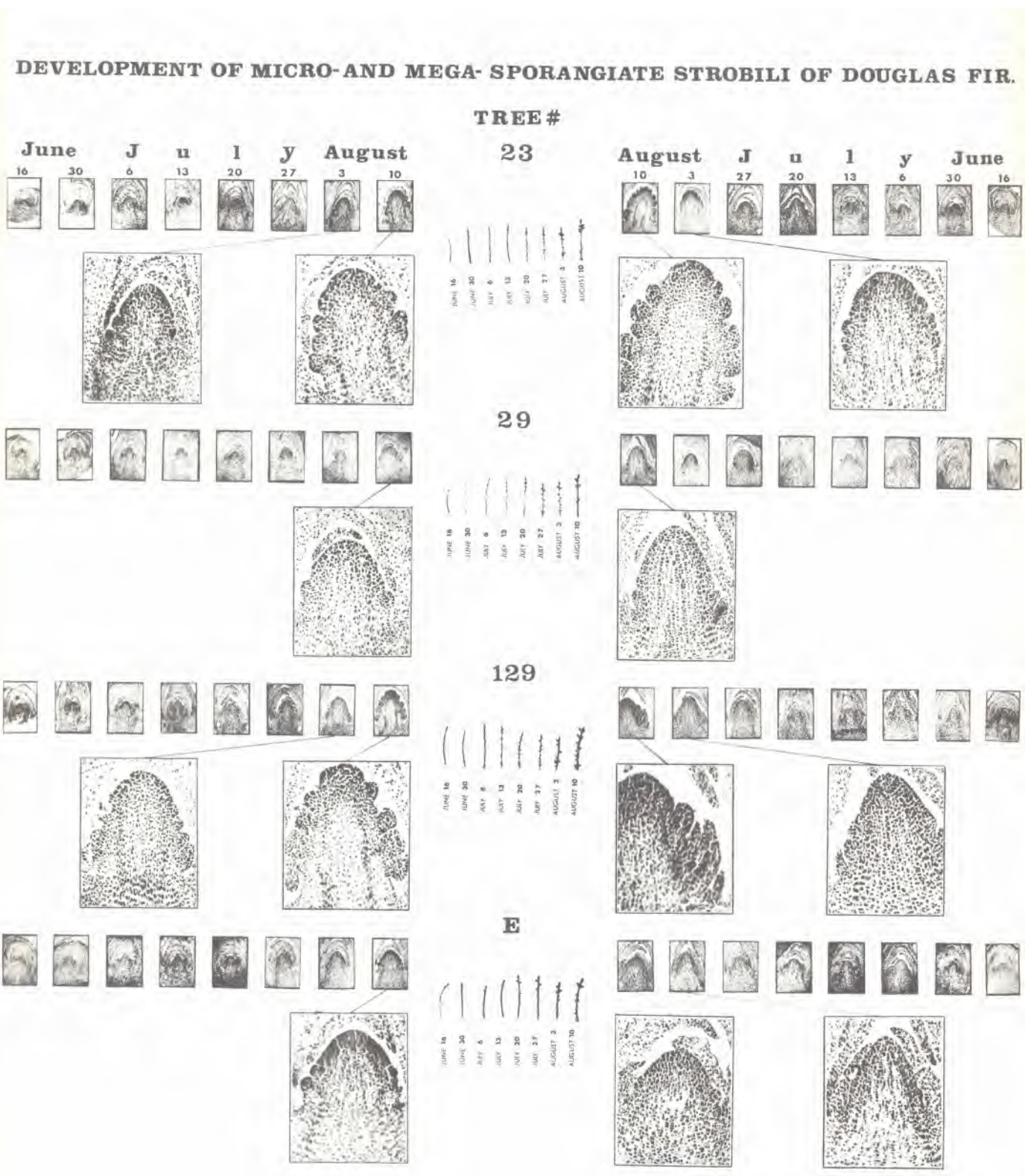
Only four of our trees have been studied to date, but we hope to utilize the other two trees later.

Slides were studied under microscope and most representative ones were photographed. Those which showed visible signs of foliar initiations were enlarged, the others are presented only as contact prints from a thirty-five millimeter film. Photographs of the twigs were also taken in order to show the chronological stages of development (see diagram).

The photographs on the right side of the diagram represent the buds from the first and second lateral positions. On the left side photographs of the lower buds are shown.

Results and Discussion

Only two of the trees were represented by both male and female strobili in the samples. This is probably due to the fact that female flowers are usually much less common than male flowers. They are restricted mostly to the first or second lateral positions on the twig, while male flowers could be found at any lateral position.


DEVELOPMENT OF MICRO-AND MEGA- SPORANGIATE STROBILI OF DOUGLAS FIR.
TREE #
23
29
129
E
June
J
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y
August
16
30
6
13
20
27
3
10

Male strobili are most advanced on tree 129. This tree has only lower positioned male buds but they are just as well developed as the top ones on tree 23. We found first signs of microsporophyll initiation on twigs collected the third of August and a week later initiation of microsporophylls was commonly seen.

Tree 23 is the next in development. The top male bud (right side of the diagram) is almost as well developed as the male on tree 129 but the lower buds are quite far behind. This seems to indicate that the male buds close to the tip of the twig develop earlier than those in the lower positions. These buds also show the first microsporophylls on the third of August although some enlarged cells can be seen a week earlier (July 27).

Tree 29 and tree E are in approximately the same developmental stage. Microsporophyll initiation just begins on the tenth of August. It is interesting to note that tree E does not display any differential development between upper and lower male strobili. This is especially striking since tree 23 repeatedly showed this difference between the two positions.

Female strobili can be recognized clearly on only two of the trees. Tree 129, of course, is far more advanced than tree 29. The former shows well developed bracts by August 10 while tree 29 has much less developed ones on the same date and its bud development can only be compared to that of tree 129 on August 3. There may be a female bud on the photograph of Tree E as of August 3, but we cannot be certain because development of tree E is very slow.

The results seem to indicate that foliar initiation in the male and female strobili became apparent at the end of July and early part of August. It is also evident that reasonably large variation exists between the development of buds from the same tree (different position) and between the development of buds collected from different trees. Variations within trees, appears to be less than the variation between trees.

On the basis of our results we conclude that the time of folial organ initiation of reproductive buds in Vancouver and Haney, British Columbia is the end of July and the first part of August. This seems to be at least two weeks later than was reported by previous workers. The reason for this difference may be due to a combination of factors. One of the more important factors is probably the differences in weather during the years the studies were made. This is noticeable even among the four trees we studied. Differences in genetic composition also exist among the trees studied. With more data a multiple regression analysis could be executed and we probably would be able to find the more important factors influencing lateral bud formation and development. One of the difficulties in collecting sufficient data for this sort of study is the fact that good flower crops are not common and some years are very poor.

Knowing the factors that influence flower bud formation we could attempt to control flower production. This line of research has already been followed by some Japanese workers with varying results in pine.

Summary

From our preliminary investigations, we conclude that the time of foliar initiations of Douglas-fir reproductive buds in 1965 in Vancouver and Haney, British Columbia was the end of July. There was a variation of about two weeks in time of bud development on our four trees.

Development of the male buds on the lower portion of the twigs generally lags behind that of buds from the top position. Male buds at the tip of the twigs seem to be larger than the male buds in lower positions.

Variation in flower bud initiation should be studied further by sampling individual trees from various provenances at different years. Statistical analysis of the data collected this way might reveal existance of factors which could be controlled to induce greater flower production.

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